AILTECH

DIVISION CUTLER-HAMMER

1A21

INSTRUCTION MANUAL

MAINTENANCE BOOK
MODEL FM-9E

-

FREQUENCY METER
DEVIATION METER
SIGNAL GENERATOR

6/69

SINGER
INSTRUMENTATION

Precision electrical and electronic instruments for measurement

emc — EMPIRE* — Gertsch* — Panoramic* — Sensitive Research*

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1. Model or Type
2. Serial Number
3. Description of trouble(2)
4. Test instruments used
5. Approximate date instrument was placed in operation
6. Approximate number of hours of use
7. Has maintenance action been previously requested?
8. Other comments

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(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

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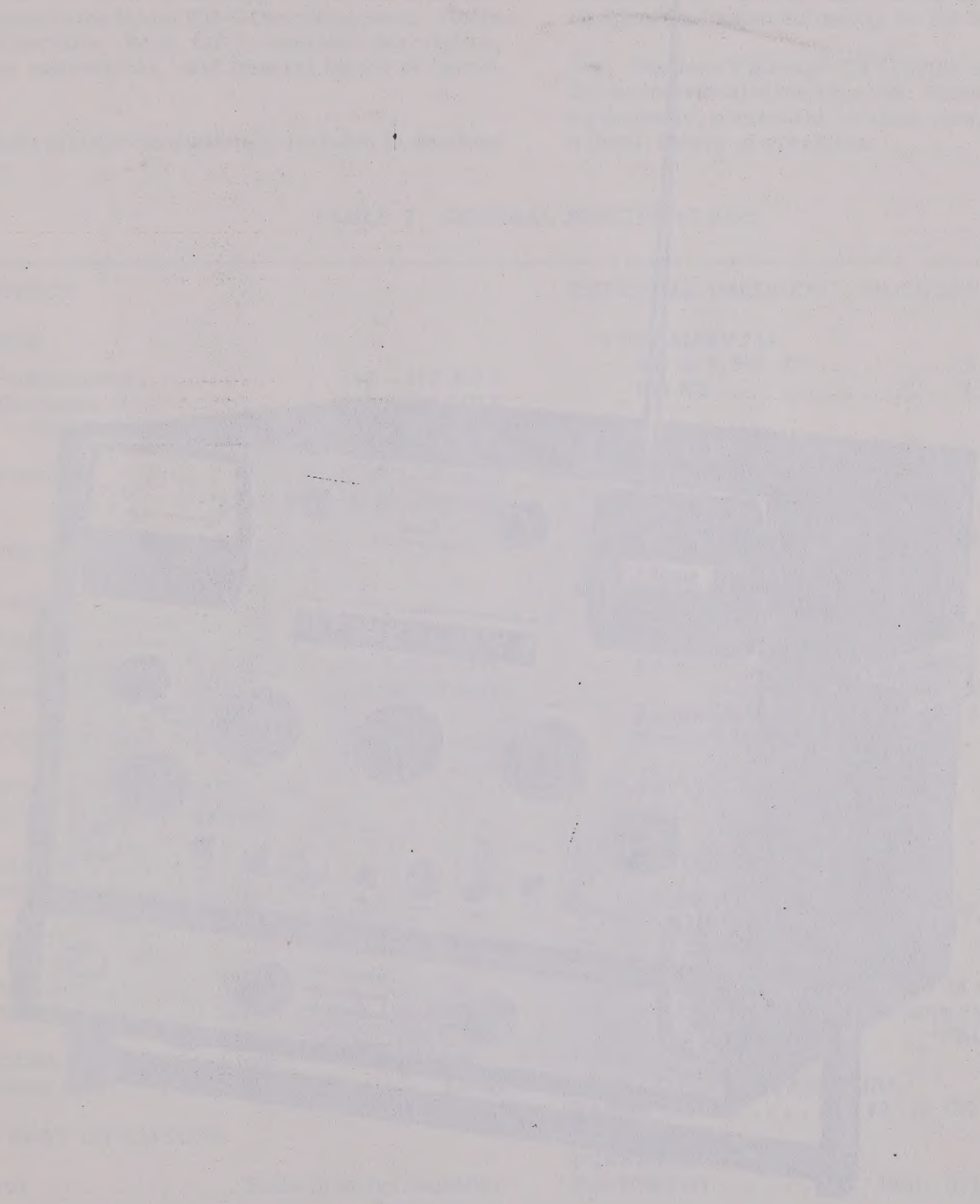


Figure 1-1. Model FM-9

SECTION I
INTRODUCTION

1-1. GENERAL.

1-2. This instruction book supplements the information included in the Model FM-9 Operation Book. Refer to the Operation Book for a complete description, operation instructions, and general theory of operation.

1-3. General maintenance data is included in sections II, III, and IV. Sections II and III provide checkout and calibration procedures. Section IV includes information to identify and locate circuit boards and components mounted directly on the chassis.

1-4. Sections V through XX provide maintenance data for the individual circuit boards. Each section includes a schematic, component location view, parts list, and a detail theory of operation.

TABLE I. GENERAL SPECIFICATIONS

FREQUENCY

RANGE

Fundamental	150 - 162 MHZ
Harmonic (3rd)	450 - 486 MHZ
(2nd through 6th also usable)	

ACCURACY ..... ± 0.0001% (± 1 ppm)
(After 30 minutes warmup)

DEVIATION MEASUREMENTS

RANGE

High	0 to 15 KHZ
Medium	0 to 5 KHZ
Low	0 to 1.5 KHZ

ACCURACY Low ..... ± 5% of full scale

SENSITIVITY, FREQUENCY, AND DEVIATION MEASUREMENTS

Fundamental	1 mv
Harmonic (3rd)	5 mv

RF OUTPUT

RANGE
Fundamental ..... 0.1 to 500 mv

ACCURACY (Calibrated into 50 ohms load) ..... ± 2 db

ZERO BEAT INDICATORS

Aural ..... Built-in audio amplifier and speaker

Visual ..... Meter

INTERNAL FREQUENCY MODULATION

Deviation ..... 0-5 KHZ at 1 KHZ

EXTERNAL FREQUENCY MODULATION

FUNDAMENTAL

300 to 3,000 HZ	5 KHZ deviation
100 HZ	2 KHZ minimum

HARMONIC (3rd)

300 to 3,000 HZ	15 KHZ deviation
100 HZ	6 KHZ minimum

Required Audio Input ... 1 vrms (approximate)

AUXILIARY OUTPUTS

IF ALIGNMENT SIGNAL

Frequency	400 - 500 KHZ, with high harmonic content
Amplitude	3 v peak to peak
Source Impedance	400 ohms

CRYSTAL CALIBRATION SIGNAL ..... 1 MHZ pulse

POWER REQUIREMENTS

AC ..... 115/230V, 50 to 400 HZ, 7 va

DC ..... 11.5 to 15 v, approximate 0.3 amp average current, NEGATIVE ground

OPERATING TEMPERATURE RANGE ..... 32° to 120°F (0° to 50°C)

FURNISHED ACCESSORY EQUIPMENT ..... Built-in battery charger and voltmeter.
Six foot coax cable, 50 ohms.
BNC to UHF connectors.
DC power cable, cigarette lighter connector.
RFA-40 attenuator.

TRANSMITTER FREQUENCY CHECK

CAUTION

Do not key transmitter when directly coupled to the FM-9. Excessive input signal will damage the instrument.

1. With the unit plugged into a suitable power source, allow a 30 minute warm-up to stabilize the crystal oven.
2. Extend internal telescoping antenna.
3. Set ANTENNA switch to IN position.
4. Turn FUNCTION switch to CAL position.
5. Set MHZ, 100 KHZ and 0-100 KHZ dials to channel frequency.

   NOTE: Fundamental channels are direct reading. Harmonic channel frequencies must be divided by 3.

6. Set 0-100 KHZ dial to nearest 5 KHZ CAL point (yellow calibration marks).

   NOTE: Fundamental channels are on calibration marks.

7. Adjust CAL knob for zero beat, using speaker and beat meter.
8. Turn FUNCTION switch to MEAS. GEN. position.
9. Reset 0-100 KHZ dial to harmonic channel divided by 3. Ignore this step for fundamental band.
10. Key the transmitter. The tone heard in the speaker is the difference between the transmitter frequency and the channel frequency. The antenna length may be adjusted for optimum coupling.
11. The transmitter may now be set by adjusting its frequency for a zero beat against the FM-9 setting, or its frequency determined by adjusting the FM-9 0-100 KHZ control for zero beat. The FM-9 dial has three 200 cycle markers on each side of the channel for this purpose.

TRANSMITTER DEVIATION CHECK

1. After the transmitter frequency has been set, change the FM-9 dial readings (either up or down) by 300 KHZ.

   NOTE: A change of only 100 KHZ is required for fundamental channels since the 3rd harmonic is being used.

2. Turn FUNCTION switch to LIM. CUR. position.
3. Key transmitter for limiter current reading. Meter reading must be above red line. If not, increase coupling and recheck frequency.
4. Turn FUNCTION switch to 5 KHZ or 15 KHZ position. Noise will cause a residual deviation reading when the transmitter is not keyed.
5. Key the transmitter and modulate by speaking into the microphone. The peak deviation is read direcly on the motor.

   NOTE: The deviation on either side of the channel frequency may be read by using the DEVIATION + - switch. The demodulated audio is present in the speaker or phone output.

RECEIVER CHECKOUT

1. Connect FM-9 CALIBRATE OUTPUT jack to receiver antenna connector.

CAUTION

Do not key transmitter while directly connected to the FM-9.

2. Set ANTENNA switch to OUT position.
3. Turn FM-9 FUNCTION switch to CAL position.
4. Set MHZ, 100 KHZ, and 0-100 KHZ dials to channel frequency.

   NOTE: Fundamental channels are direct reading. Harmonic channel frequencies must be divided by 3.

5. Set 0-100 KHZ dial to nearest 5 KHZ CAL point (yellow calibration marks).
6. Adjust CAL knob for zero beat, using speaker and beat meter.
7. Turn FUNCTION switch to MEAS. GEN. position.
8. Reset 0-100 KHZ dial to harmonic channel divided by 3. Ignore this step for fundamental band.
9. Adjust RF OUTPUT controls to desired output level.
10. Discriminator center of receiver may now be set and sensitivity checked. The FM-9 output may be adjusted to as low as 0.5 uv.
11. The output of the FM-9 may be frequency modulated with the internal 1 KHZ oscillator by applying a 0 to 1 vrms tone to the EXT. MOD connector.

SECTION II
FIELD MAINTENANCE

2-1. GENERAL.

2-2. With limited field facilities, maintenance should be limited to (1) 1 MHZ calibration, (2) calibration of the 0-100 KHZ dial, and (3) adjustment of the battery charge circuit. Refer to Section III for additional maintenance and checkout procedures.

2-3. To remove the covers from the unit, proceed as follows:

a. Unscrew the two knobs which secure the carrying handle. Remove the handle.

b. Remove the two circular plates located under the handle knobs. Each plate is attached with two screws.

c. Remove the six screws which attach the covers to the back panels.

d. Separate the top and bottom covers from the unit.

e. Refer to Section IV for location of the various component boards.

2-4. 1 MHZ CALIBRATION.

2-5. To ensure accuracy, check calibration of the 1 MHZ crystal every 30 days. To check and adjust the crystal, either a primary standard or a standard frequency receiver is required. For the high frequency broadcasts, a receiver such as Gertsch Model RHF-1 is required. For the very low frequency broadcasts, a phase comparison receiver such as Gertsch Model RLF-1 is required. To check and adjust the receiver, proceed as follows:

a. Connect Model FM-9 to a power source and allow at least 30 minute crystal warmup. Make certain the OVEN light is cycling on and off.

b. Connect 1 MHZ OUTPUT jack J1606 to the comparison (Fx) input of the standard or receiver.

c. Turn FM-9 power switch ON. The remaining controls of the FM-9 do not affect the 1 MHZ output signal.

d. Proceed with the frequency check.

e. Make certain that the crystal is accurate to one part in 10^{-7} or better. Adjust MHZ ADJ capacitor C1648 as required to obtain accuracy within limits.

2-6. LFO DIAL CALIBRATION.

2-7. During normal operation, the 0-100 KHZ dial is calibrated from the front panel with the 0-100 KHZ CALIBRATE control. If zero beats cannot be obtained at the low or high ends, the dial should be recalibrated. A frequency counter or some means of measuring frequencies in the 400 to 500 KHZ range is required. Reset the low and high ends as follows:

a. Remove covers. See paragraph 2-3.

b. Turn power on and allow a 30 minute warmup.

c. Connect frequency measuring device to the LFO OUTPUT jack J1605.

d. Set the CALIBRATE control to the approximate mid point.

e. Set the 0-100 KHZ dial to 000 (ccw).

f. Adjust coil L101 (see section 5) to set the LFO to 400 KHZ.

g. Set 0-100 KHZ dial to 000 (cw).

h. Adjust capacitor C1645 to set LFO to 500 KHZ. The dual screwdriver controls for the capacitor are accessible from the side of the unit.

i. Turn FUNCTION switch to CAL.

j. Check that zero beat may be obtained with the CALIBRATE control.

k. Repeat step j with LFO dials set to 500 and 050.

2-8. BATTERY CHARGE CIRCUIT ADJUSTMENTS.

2-9. To adjust the battery charge voltage and meter calibration, proceed as follows:

a. Connect power cord to a vac outlet.

b. Slide 115/230 volt switch to position matching the voltage of the power source.

c. Slide dc/ac switch to ac.

d. Turn POWER switch ON.

e. Turn BATTERY CHARGE switch to CHARGE.

f. Connect dc voltmeter to DC INPUT jack J1608.

g. Adjust potentiometer R913 (see section 13) to set battery charge voltage to the maximum charge level.

h. Adjust potentiometer R914 to set FM-9 meter to the same reading as the external voltmeter.

SECTION III
SHOP MAINTENANCE

3-1. GENERAL.

3-2. This section includes maintenance procedures recommended for calibration laboratories or similarly equipped facilities. The maintenance procedures consist of checkout and adjustment procedures and trouble-shooting notes. Refer to paragraph 2-3 for cover removal.

3-3. ADJUSTMENTS.

3-4. FIELD CALIBRATION. Perform adjustment procedures outlined in Section II before proceeding with the adjustment listed below.

3-5. POWER SUPPLY. To check the 9 volt output of the supply, a dc voltmeter is required. Proceed as follows:

a. Connect unit to an ac power source and turn power switch on.

b. Turn BATTERY CHARGE switch to OPERATE.

c. Measure output voltage of supply (across capacitor C907).

d. Adjust potentiometer R909 (see section 13) to set voltage to 9 vdc.

e. If adjustment was required, repeat procedure of paragraph 2-9.

3-6. DIVIDERS. To check the dividers, a frequency counter is required. Proceed as follows:

a. Turn FUNCTION switch to CAL.

b. Connect counter to TP11 (see figure 3-1).

c. Center coil L701 in the range over which the divider output is 100 KHZ.

d. Connect counter to TP10.

e. Center coil L702 in the range over which the divider is 5 KHZ.

3-7. 17 TO 28 MHZ OSCILLATOR. To tune the oscillator, a means for measuring signals in the 17 to 28 MHZ range is required. Exact frequency measurement is not required. The measuring device need only distinguish between 1 MHZ steps. To tune the oscillator, proceed as follows:

a. Connect dc voltmeter to TP12.

b. Connect frequency measuring device to TP3. Make certain input impedance of device is 100 k or more.

c. Set the MHZ dial to 152 mc.

d. Check that oscillator frequency is 17 MHZ. If required retune oscillator with trimmer capacitor C1601.

e. Check that a steady dc voltage (indicating lock) is measured at TP12 with the frequency measuring device connected and disconnected.

f. Repeat procedure for the following dial settings:

KHZ DIAL	OSCILLATOR FREQUENCY	TRIMMER CAPACITOR
150	17 MHZ	C1601
151	18 MHZ	C1602
152	19 MHZ	C1603
153	20 MHZ	C1604
154	21 MHZ	C1605
155	22 MHZ	C1606
156	23 MHZ	C1607
157	24 MHZ	C1608
158	25 MHZ	C1609
159	26 MHZ	C1610
160	27 MHZ	C1611
161	28 MHZ	C1612

3-8. 2.6 TO 3.5 MHZ OSCILLATOR. To tune the oscillator, a means for measuring signals in the 2.6 to 3.5 MHZ range is required. Exact frequency measurement is not required. The measuring device need only distinguish between 100 KHZ steps. To tune the oscillator proceed as follows:

a. Connect dc voltmeter to TP6.

b. Connect frequency measuring device to TP5.

c. Set the 100 KHZ dial to 9.

d. Check that oscillator frequency is 3.5 MHZ. If required, retune oscillator with trimmer capacitor C1644.

e. Check that a steady dc voltage (indicating lock) is measured at TP6 with the frequency measuring device connected and disconnected.

f. Repeat procedure for the following dial settings:

100 KHZ DIAL	OSCILLATOR FREQUENCY	TRIMMER CAPACITOR
9	3.5	C1644
8	3.4	C1643
7	3.3	C1642
6	3.2	C1641
5	3.1	C1640
4	3.0	C1639
3	2.9	C1638
2	2.8	C1637
1	2.7	C1636
0	2.6	C1635

3-9. 20 TO 32 MHZ AMPLIFIER. To tune the amplifier, a means for measuring relative signal amplitudes in the 20 to 32 MHZ range is required. To tune the amplifier proceed as follows:

a. Set 0-100 KHZ dials to 000 and 100 KHZ dial to 5.

b. Connect amplitude measuring device to TP2.

c. Set MHZ dial to 152 (152.5000 MHZ).

d. Tune for maximum amplitude and trimmer capacitor C1613.

e. Repeat procedure for the following dial settings:

DIAL SETTINGS	TRIMMER CAPACITOR
150.5000	C1613
151.5000	C1614
152.5000	C1615
153.5000	C1616
154.5000	C1617
155.5000	C1618
156.5000	C1619
157.5000	C1620
158.5000	C1621
159.5000	C1622
160.5000	C1623
161.5000	C1624

3-10. 3 TO 4 MHZ AMPLIFIER. To tune the amplifier, a means for measuring relative signal amplitudes in the 3 to 4 MHZ range is required. To tune the amplifier proceed as follows:

a. Set the LFO dials to 500.

b. Connect amplitude measuring device to TP4.

c. Set 100 KHZ dial to 9.

d. Tune for maximum amplitude with trimmer capacitor C1634.

e. Repeat procedure for the following dial settings:

100 KHZ DIAL	TRIMMER CAPACITOR
9	C1634
8	C1633
7	C1632
6	C1631
5	C1630
4	C1629
3	C1628
2	C1627
1	C1626
0	C1625

3-11. DEVIATION METER ZERO SET. To set the circuit to a center frequency of 300 KHZ, proceed as follows:

a. Connect 300 KHZ signal to INPUT/OUTPUT Jack J1601.

b. Turn FUNCTION switch to 1.5 KHZ.

c. Adjust potentiometer R210 to obtain a zero indication on the meter.

3-12. DEVIATION METER CALIBRATION. To calibrate the meter, a signal with a precisely known FM deviation is required. To calibrate the meter proceed as follows:

a. Set the FM-9 to the incoming signal as outlined in the transmitter deviation check portion of table 2.

b. Turn FUNCTION switch to 5 KHZ.

c. Apply a deviation of 5 KHZ to the incoming signal.

d. Adjust potentiometer R226 to obtain a 5 KHZ indication on the meter.

e. Turn DEVIATION switch to alternate position and check meter indication. If required, adjust potentiometer R236 for a compromise setting.

f. Turn FUNCTION switch to 15 KHZ.

g. Apply a deviation of 15 KHZ to the incoming signal.

h. Adjust potentiometer R224 to obtain a 15 KHZ indication on the meter.

i. Turn DEVIATION switch to alternate position and check meter indication. If required, adjust potentiometer R236 for a compromise setting.

j. Turn FUNCTION switch to 1.5 KHZ.

k. Apply a deviation of 1.5 KHZ to the incoming signal.

l. Adjust potentiometer R238 to obtain a 1.5 KHZ indication on the meter.

m. Turn DEVIATION switch to alternate position and check meter indication. If required, adjust potentiometer R238 for a compromise setting.

3-13. TROUBLESHOOTING.

3-14. The following procedure is intended to assist in localizing troubles to a stage or series of stages. The procedure may also be used as a final checkout procedure for the unit.

3-15. POWER SUPPLY.

a. Check that OVEN light cycles on and off after a suitable warmup. To check all power input circuits, check with 115 vac, 230 vac, and 12 vdc inputs.

   1. Failure of the light to cycle indicates troubles in the crystal oven circuit or the power input circuit.

b. Check 13.5 vdc per paragraph 2-9 and 9 vdc per paragraph 3-5.

   1. Failure to obtain required output voltages indicates troubles in the regulator circuit.

3-16. 1 MHZ CIRCUITS.

a. Check 1 MHZ output per paragraph 2-5.

1. Erratic or inaccurate output indicates troubles in the crystal oscillator A1611, crystal CR1601, or with the crystal oven circuit.

2. No output indicates troubles in the crystal oscillator A1611 or the spike generator A1608.

b. Check divider output per paragraph 3-6.

1. Erratic 100 KHZ output indicates troubles in the buffer Q701 or the 10:1 divider.

2. Erratic 5 KHZ output indicates troubles in the 20:1 divider.

3-17. LFO (INTERPOLATING OSCILLATOR).

a. Check LFO end points per paragraph 2-7, steps a through g.

1. Erratic output indicates troubles in the LFO A1615.

2. No output indicates troubles in the LFO or buffer Q303.

b. Check LFO calibrate beat notes per paragraph 2-7, steps i through k.

1. No beat notes indicates troubles with the audio circuits A1606.

2. Lack of beat note control indicates troubles in the LFO.

3-18. 17 TO 28 MHZ OSCILLATOR.

a. Check tuning of oscillator per paragraph 3-7.

1. No output at TP3 indicates troubles in oscillator Q1403.

2. A varying dc output at TP12 indicates loss of lock. The trouble is probably in shaper Q1401 and Q1402 or the phase detector.

3. An erratic dc output at TP12 indicates troubles in sweep generator Q301 and Q302 or in the phase detector.

3-19. 2.6 TO 3.5 MHZ OSCILLATOR.

a. Check tuning of oscillator per paragraph 3-8.

1. No output at TP4 indicates troubles is oscillator Q1504.

2. A varying dc output at TP6 indicates loss of lock. The trouble is probably in blocking oscillator Q1502 or the phase detector.

3-20. IF CHECK.

a. With a frequency measuring device, check that output at TP1 is between 20 and 32 MHZ.

1. An output varying in frequency within the 20 to 32 MHZ range indicates loss of lock. Proceed with the checkout procedure.

2. No output in the range indicates troubles in the multiplier circuits, HFO Q1004 or mixer Q1003.

b. Tune 20 to 32 MHZ amplifier per paragraph 3-9.

1. No output indicates troubles in amplifier Q1404.

c. Tune 3 to 4 MHZ amplifier per paragraph 3-10.

1. No output indicates troubles in mixer Q1501 or amplifier Q1503.

d. With a frequency measuring device, check that output at TP7 is between 400 and 500 KHZ.

1. No output indicates troubles in mixer-amplifier A1613.

e. Check dc voltage at TP8.

1. A varying dc voltage indicates troubles in phase detector A1614 or the HFO Q1004.

3-21. OUTPUT CHECK.

a. Check frequency of a transmitter with a known frequency.

1. No beat notes indicates troubles in buffer Q1002, the harmonic generator, or beat detector Q1001.

2. Erratic beat notes indicates troubles in the HFO.

b. Measure output at J1601 as the RF OUTPUT control is varied.

1. No output indicates troubles in the attenuators.

2. Lack of control indicates troubles in the attenuator or buffer Q1002.

3-22. DEVIATION METER CHECKS.

a. Operate equipment per steps 1, 2, and 3 of the transmitter deviation check section of page 1-2.

1. If a limiter current reading above the red line cannot be obtained, the trouble is probable in the IF amplifiers Q501 and Q502 or limiter Q503 and Q504.

b. Check meter calibration per paragraph 3-12.

1. Inability to calibrate the meter indicates troubles in the detector drive circuits or in the meter.

3-23. DEVIATION METER CALIBRATION CHECK (ALTERNATE METHOD). To check the full scale readings of the meter, proceed as follows (carrier null method):

a. Operate transmitter at a convenient carrier frequency.

b. Connect audio oscillator to the external modulation input of the FM generator. Operate audio oscillator at 577.8 cps and zero amplitude.

c. Operate the Model FM-9 as a frequency meter and zero beat against the carrier frequency (see Operation Manual).

d. Adjust Model FM-9 to obtain a low but clearly audible beat frequency note. A beat note of approximately 200 to 300 cps should provide adequate results. Use headset to monitor beat note.

e. Increase amplitude of audio oscillator until the beat note against carrier disappears. Amplitude should be increased slowly and the beat note should be monitored carefully to make certain that the correct beat note disappearance is selected.

f. Continue increasing amplitude until the third disappearance of the beat note against carrier occurs. Carefully adjust amplitude to center the control in the range of the beat note disappearance. At this point, the FM generator is operating with a deviation of 5 KHZ.

g. Reset the Model FM-9 to a frequency 300 KHZ below the carrier frequency of the transmitter.

h. Turn FUNCTION switch to the FREQ. SET position.

i. Operate the FM generator with no modulation applied. This may be accomplished by disconnecting the audio oscillator. Do not change frequency or amplitude settings of audio oscillator.

j. Adjust Model FM-9 as required to set the deviation meter to the FREQ. SET red line.

k. Turn FUNCTION switch to the 5 KHZ position.

l. Turn DEVIATION switch to the + position.

m. Apply modulation to the FM generator.

n. The peak deviation meter should indicate 5 KHZ ± 5%.

o. Reset the Model FM-9 to a frequency 300 KHZ above the carrier frequency of the transmitter. Repeat steps h, i, j, and k.

p. The peak deviation meter should indicate 5 KHZ ± 5%.

1. If the readings of steps n and p differ, this indicates trouble in the input signal (distortion, unequal sidebands, etc.).

2. If the readings are equal but out of specification, the most probable source of trouble is the discriminator and meter drive.

q. Turn DEVIATION switch to the - position.

r. The peak deviation meter should indicate 5 KHZ ± 5%.

s. Check that audio signal of approximately 577.8 cps is present.

t. Repeat procedure for the 15 KHZ range using a modulation frequency of 1.7333 KHZ.

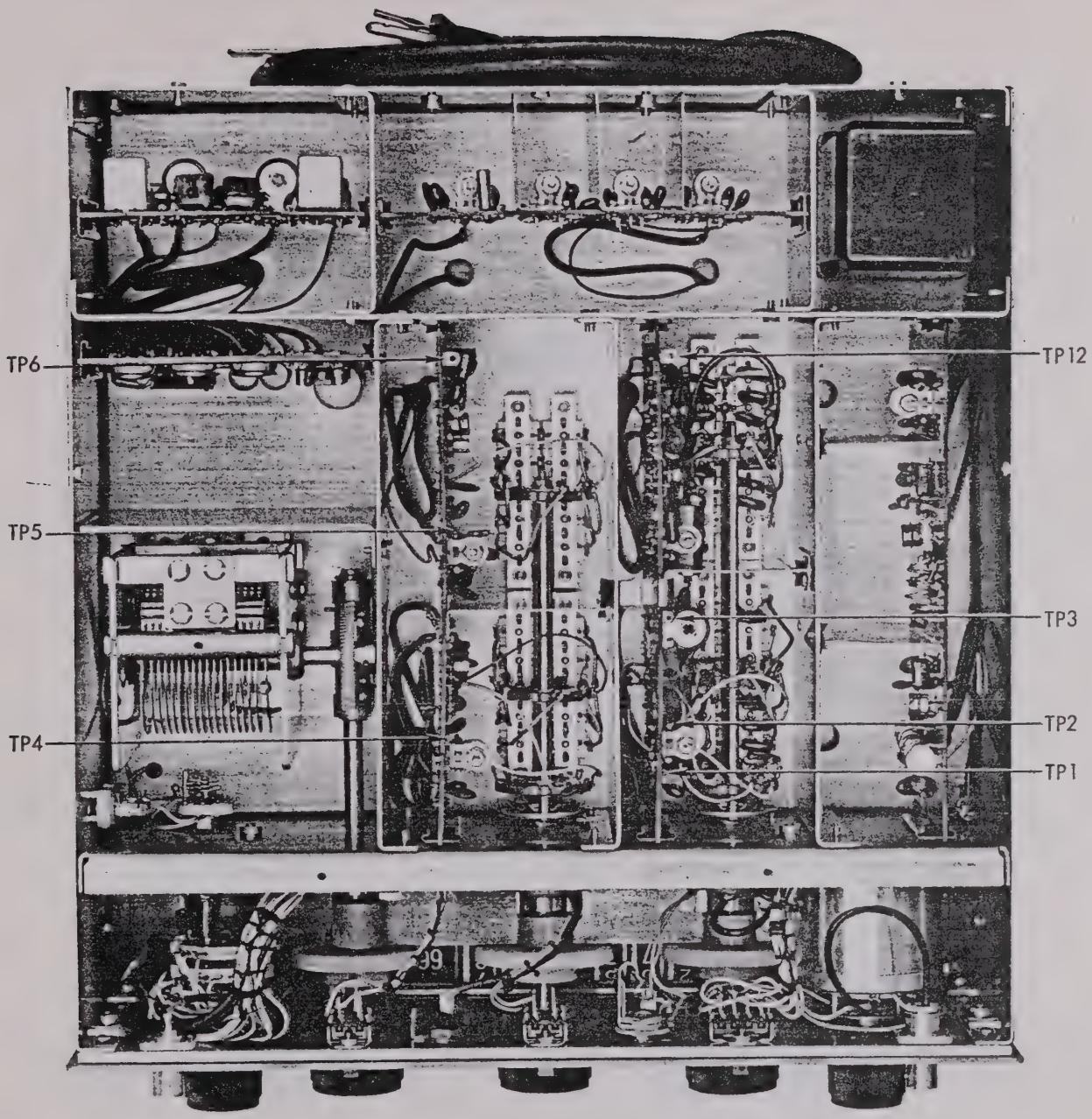


Figure 3-1. Test Points (Sheet 1 of 2)

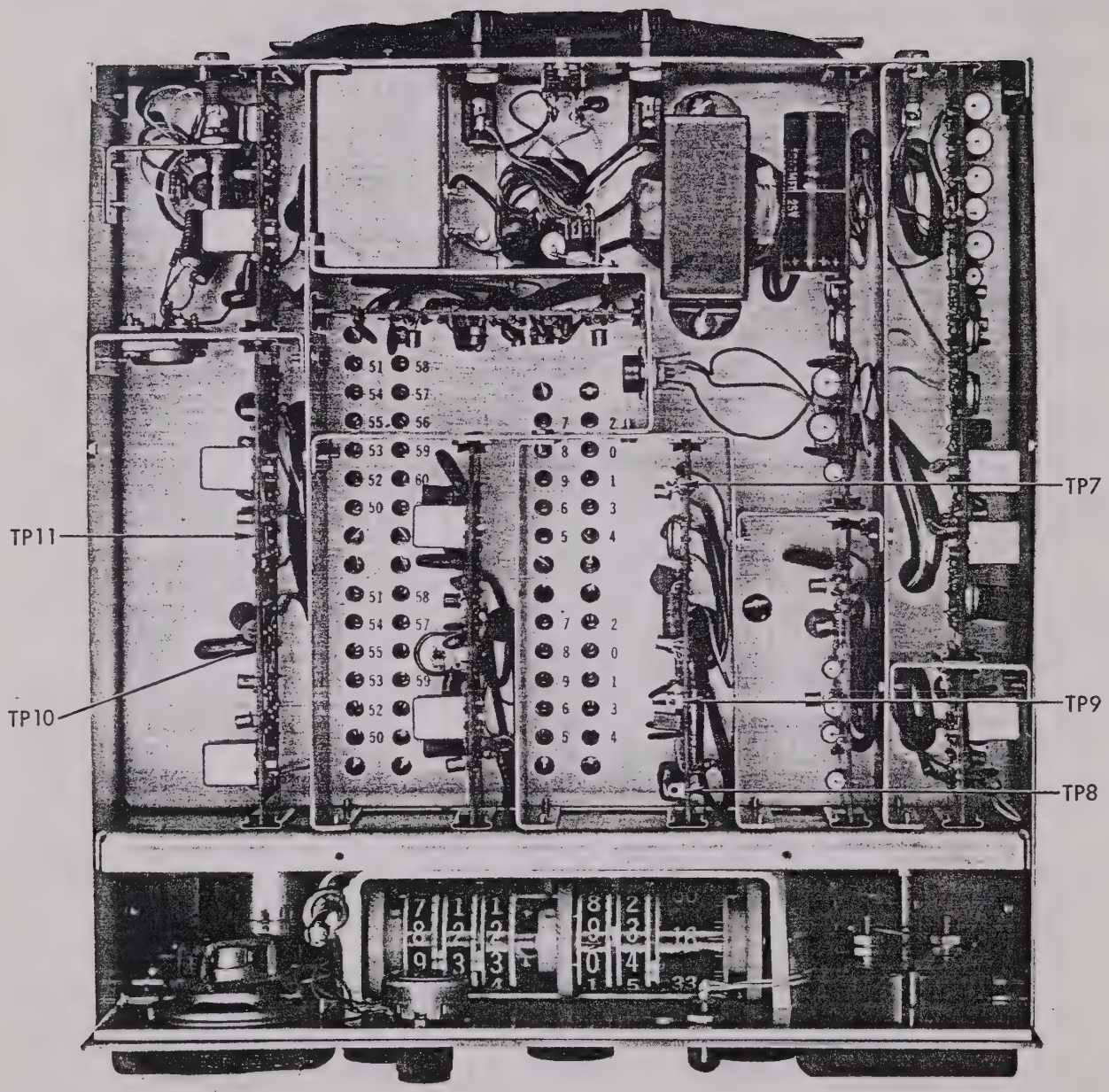


Figure 3-1. Test Points (Sheet 2 of 2)

SECTION IV

MAIN CHASSIS COMPONENTS
(See figures 4-2 through 4-7)

REF DESIG	FIG. NO.	ITEM	PART NO.	MFR
A1602	4-4	Board Assy, IF Amplifier and limiter (See Section IX)	AA-1127	Singer
A1603	4-4	Board Assy, Discriminator and meter (See Section VI)	1-002552-001	Singer
A1604	4-5	Board Assy, High frequency oscillator (See Section XIV)	AA-1129	Singer
A1605	4-5	Board Assy, 1 MHZ multiplier (See Section XVI)	AA-1130	Singer
A1606	4-5	Board Assy, Audio (See Section XV)	AA-1131	Singer
A1607	4-5	Board Assy, 1 MHZ selector (See Section XVIII)	AA-1132	Singer
A1608	4-4	Board Assy, 1 MHZ spike generator (See Section X)	AA-1133	Singer
A1609	4-4	Board Assy, Power supply (See Section XIII)	AA-1134	Singer
A1610	4-5	Board Assy, 100 KHZ selector (See Section XIX)	AA-1135	Singer
A1611	4-4	Board Assy, Crystal oscillator (See Section XII)	AA-1136	Singer
A1612	4-4	Board Assy, Frequency dividers (See Section XI)	AA-1137	Singer
A1613	4-5	Board Assy, 400 to 500 KHZ IF (See Section XVII)	AA-1138	Singer
A1614	4-4	Board Assy, Phase detector and sweep gate (See Section VIII)	AA-1139	Singer
A1615	4-4	Board Assy, Low frequency oscillator (See Section V)	AA-1140	Singer
A1616	4-4	Board Assy, 3 cycle sweep and LFO buffer (See Section VII)	AA-1141	Singer
A1617	4-4	Board Assy, 1 KHZ oscillator (See Section XXI)	AA-1312	Singer
AT1601	4-2	Attenuator, variable	AA-2437	Singer
AT1602	4-6	Attenuator, fixed, 20db	AA-1313-2	Singer
C1601 thru C1606	4-7	Capacitor, trimmer, 3 to 35 pf	403	Elmenco
C1607 thru C1612	4-6	Capacitor, trimmer	402	Elmenco
C1613 thru C1624	4-7	Capacitor, trimmer	402	Elmenco
C1625 thru C1634	4-6	Capacitor, trimmer	402	Elmenco
C1635 thru C1644	4-7	Capacitor, trimmer	402	Elmenco
C1645	4-5	Capacitor, dual trimmer, 5 to 25 pf	3153-000-NPO	Erie
C1646	4-5	Capacitor, variable, 17 to 360 pf	CA-8	Singer
C1647	4-5	Capacitor, trimmer, 1.8 to 8.7 pf	160-104	Johnson

REF DESIG	FIG. NO.	ITEM	PART NO.	MFR
C1648	4-3	Capacitor, variable, 0.6 to 14 pf	VC-11GF	J-F-D
C1649	4-6	Capacitor, mica, 150 pf	DM15E151J	Elmenco
C1650	4-6	Capacitor, mica, 120 pf	DM15E121J	Elmenco
C1651	4-6	Capacitor, mica, 82 pf	DM15E820J	Elmenco
C1652	4-6	Capacitor, mica, 82 pf	DM15E820J	Elmenco
C1653	4-6	Capacitor, mica, 68 pf	DM15E680J	Elmenco
C1654	4-6	Capacitor, mica, 47 pf	DM15E470J	Elmenco
C1655	4-6	Capacitor, mica, 43 pf	DM15E430J	Elmenco
C1656	4-6	Capacitor, mica, 27 pf	DM15E270J	Elmenco
C1657	4-6	Capacitor, mica, 15 pf	DM15E150J	Elmenco
C1658	4-6	Capacitor, mica, 10 pf	DM15E100J	Elmenco
C1659	4-7	Capacitor, mica, 33 pf	DM15E330J	Elmenco
C1660	4-7	Capacitor, mica, 27 pf	DM15E270J	Elmenco
C1661	4-7	Capacitor, mica, 27 pf	DM15E270J	Elmenco
C1662	4-7	Capacitor, mica, 15 pf	DM15E150J	Elmenco
C1663		Part of FL1601		
C1664		Part of FL1601		
C1665		Part of FL1601		
C1666	4-4	Capacitor, electrolytic, 100 uf, 15 v	P65AN2610015	MEC
C1667	4-4	Capacitor, electrolytic, 25 uf, 15 v	P65AG122515	MEC
C1668	4-5	Capacitor, ceramic disc, .001 uf	861Z5410ZZ	Erie
CR1601	4-5	Crystal Assembly, 1 MHZ, 12 vdc oven	TCO-11RD-4	Bliley
CR1602	4-4	Diode	SC-2	Semtech
CR1603	4-4	Diode, Zener 9 v	1N1511A	
DS1601	4-2	Lamp	344	GE
F1601	4-3	Fuse, 0.25 amp	MDL-1/4	Bussmann
F1602	4-3	Fuse, 1 amp	MDL-1	Bussmann
FL1601	4-4	Filter	AA-1125	Singer
J1601	4-2	Connector, BNC	2230-7	Dage
J1602	4-2	Jack, phone	12A	Switchcraft
J1603	4-3	Jack, red	108-902	E. F. Johnson
J1604	4-3	Jack, black	108-903	E. F. Johnson
J1605	4-2	Jack, black	108-903	E. F. Johnson
J1606	4-3	Jack, red	108-902	E. F. Johnson
J1607	4-2	Connector, BNC	UG-911/U	
J1608	4-3	Connector, phono	S-PM-1	Singer

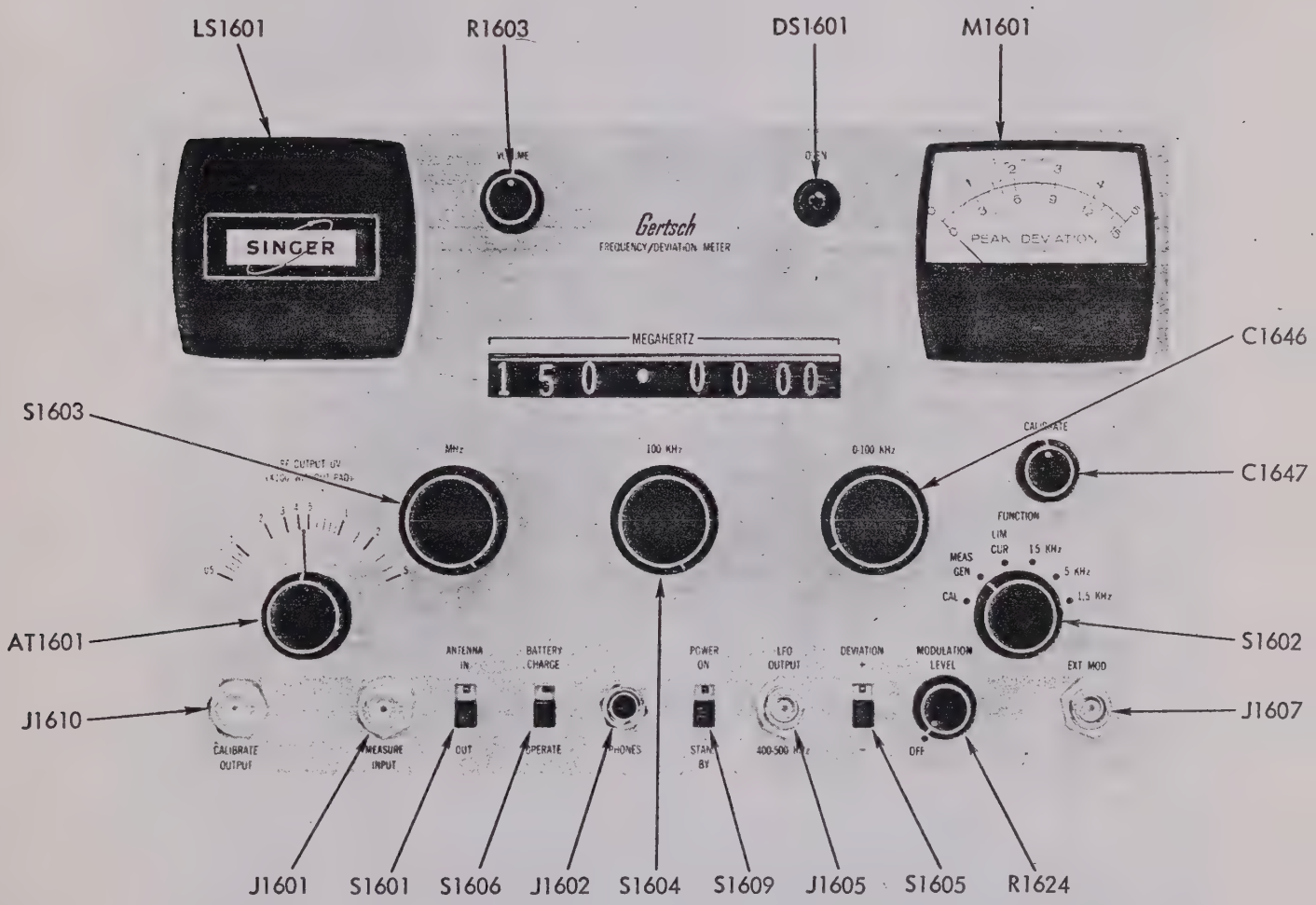


Figure 4-2. Front Panel

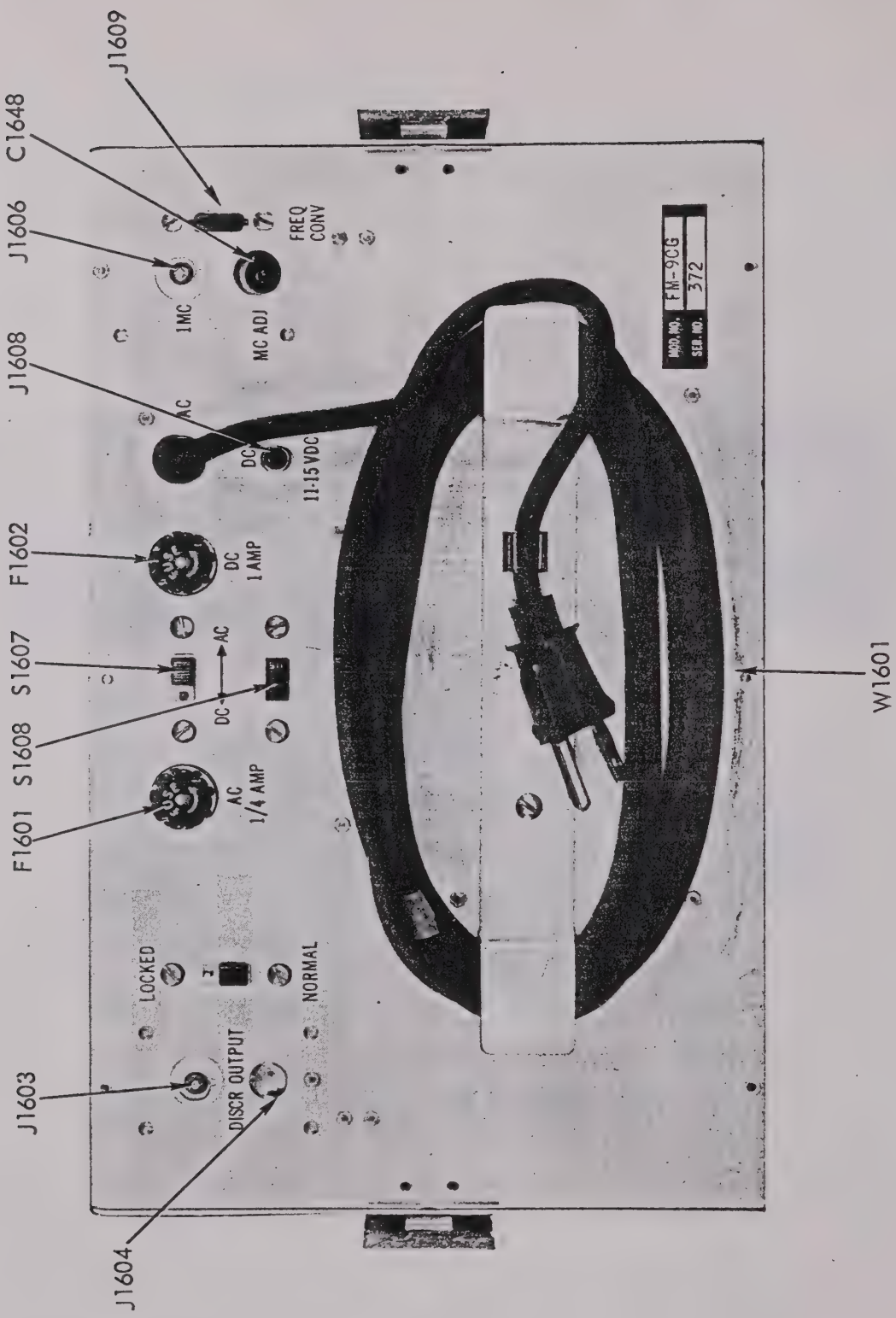


Figure 4-3. Back Panel

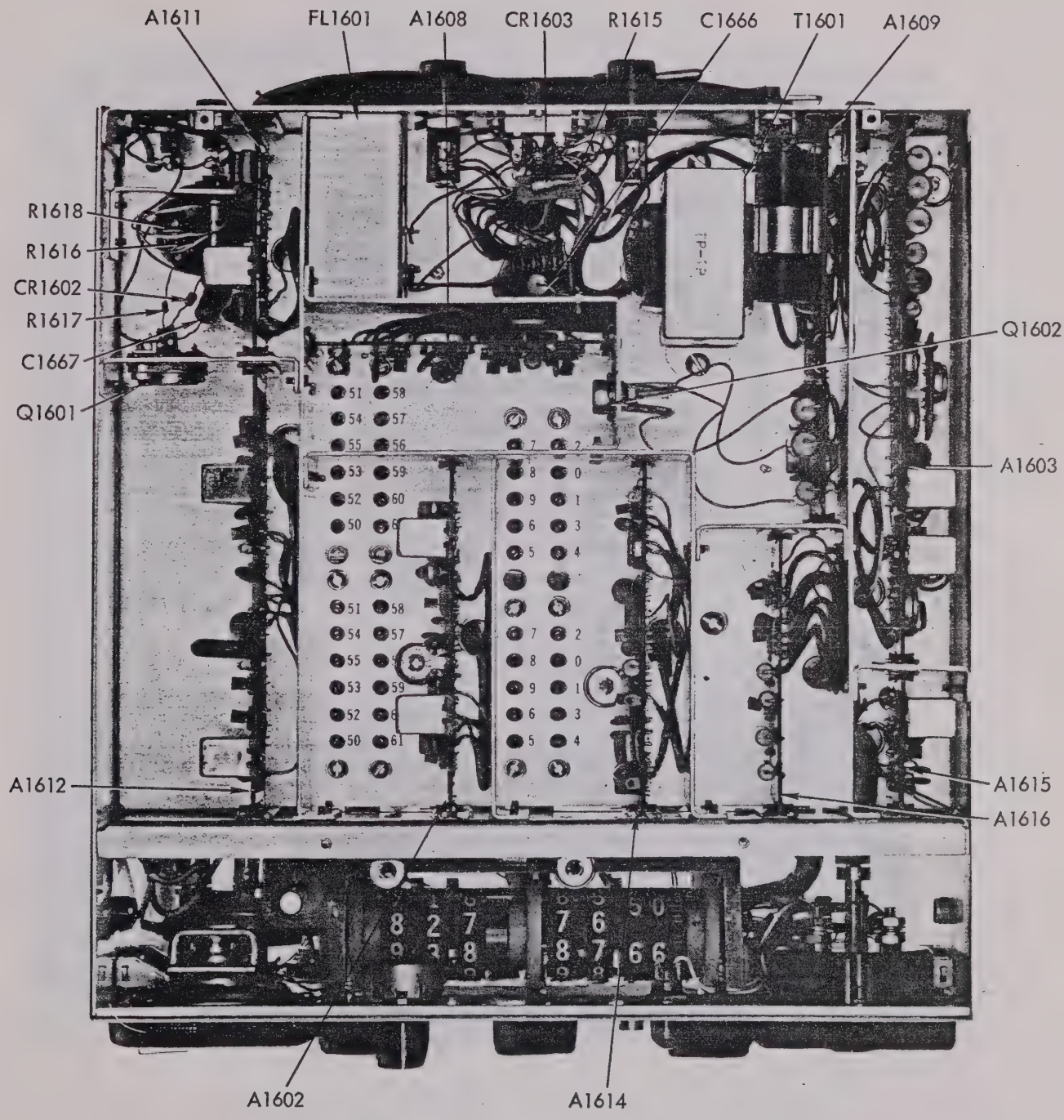


Figure 4-4. Top Chassis View

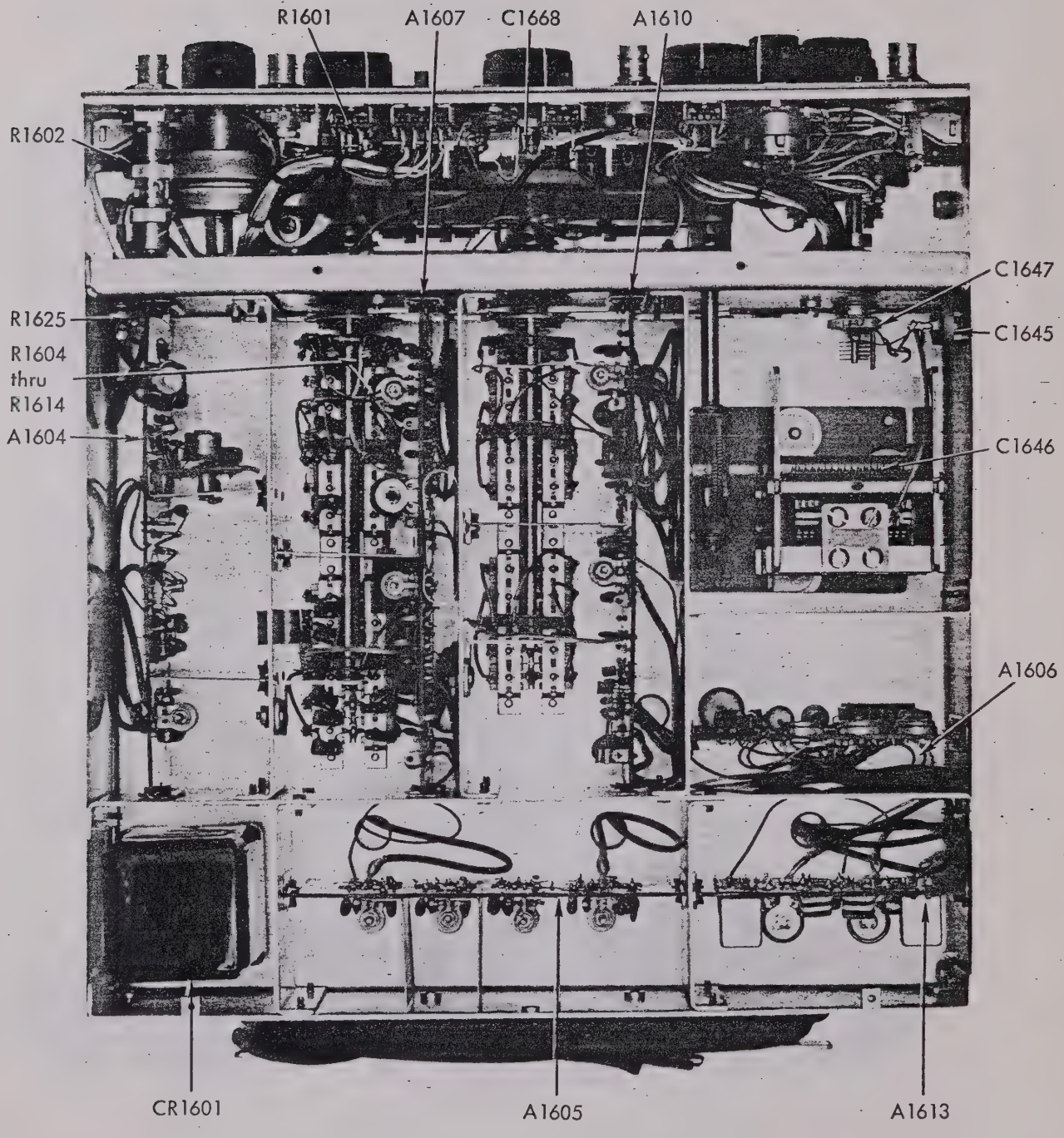


Figure 4-5. Bottom Chassis View

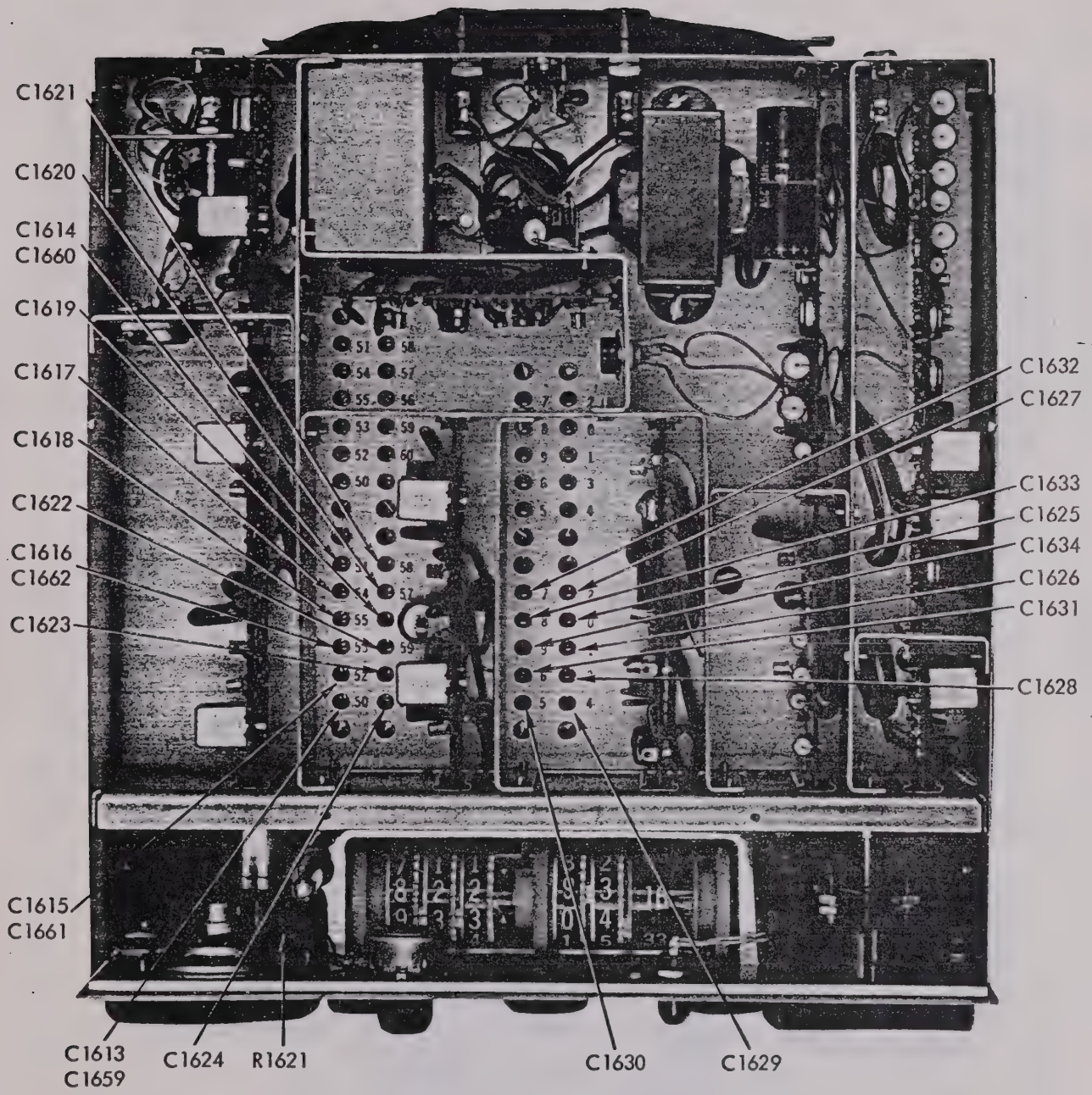


Figure 4-6. Tuning Capacitors

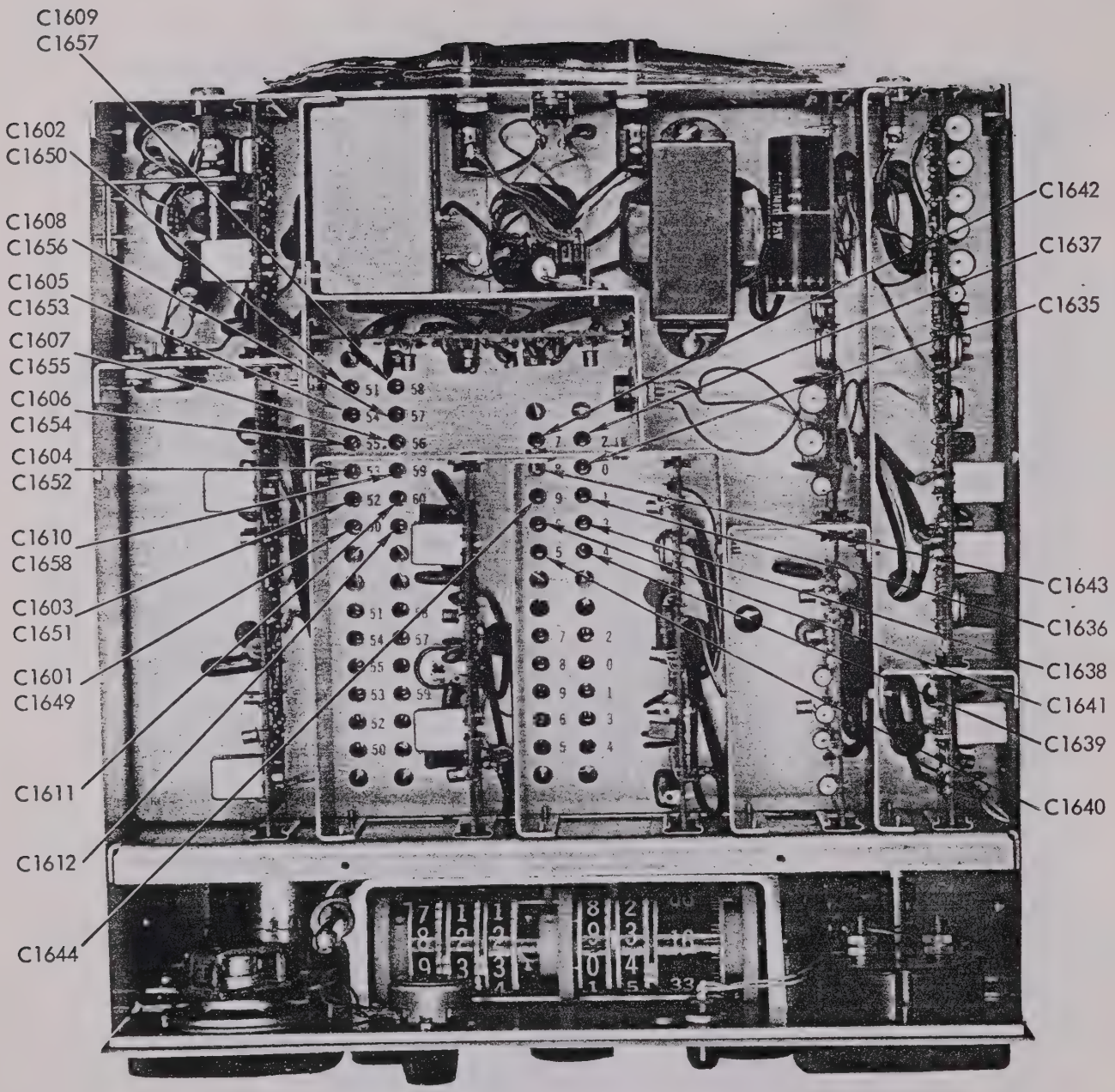
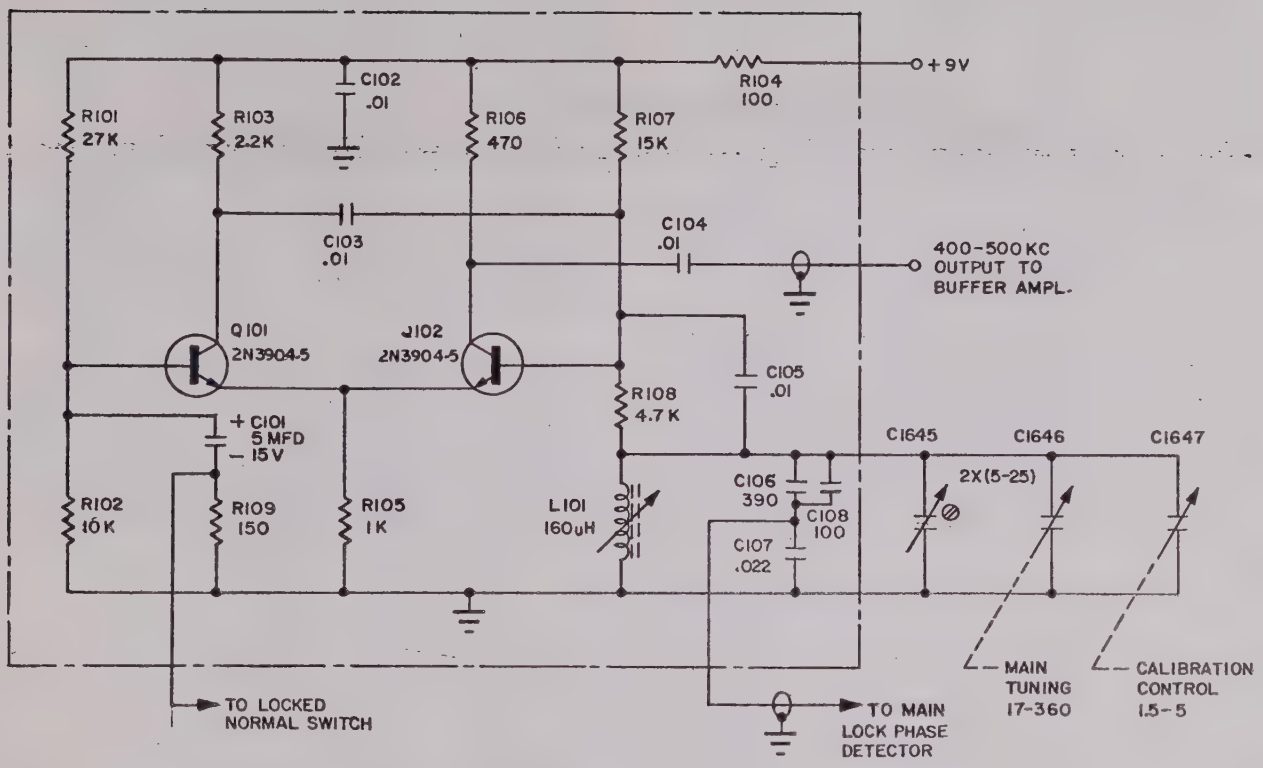


Figure 4-7. Tuning Capacitors



NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ± 10% 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.

Figure 5-1. Schematic (Low Frequency Oscillator)

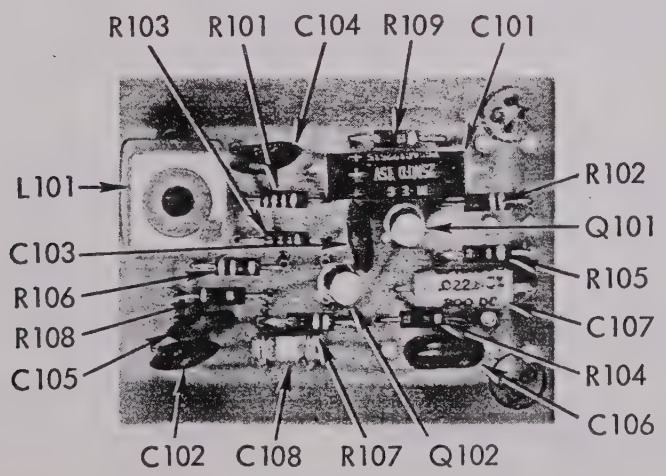


Figure 5-2. Component Location (Low Frequency Oscillator)

REF DESIG	ITEM	PART NO.	MFR
C101	Capacitor, mylar, 25 uf, 15 vdc	P65AG122515	MEC
C102	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C103	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C104	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C105	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C106	Capacitor, mica, 390 pf	DM15E391J	Elmenco
C107	Capacitor, mylar, 0.022 uf, 200 vdc	192P22392	Sprague
C108	Capacitor, 100 pf	TCN-100	Centralab
L101	Choke, 160 uh	EP-67	Singer
Q101	Transistor	2N3904	
Q102	Transistor	2N3904	
R101	Resistor, composition, 27K ±10%, 1/4 watt		
R102	Resistor, composition, 10K ±10%, 1/4 watt		
R103	Resistor, composition, 2.2K ±10%, 1/4 watt		
R104	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R105	Resistor, composition, 1K ±10%, 1/4 watt		
R106	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R107	Resistor, composition, 15K ±10%, 1/4 watt		
R108	Resistor, composition, 4.7K ±10%, 1/4 watt		
R109	Resistor, composition, 150 ohms ±10%, 1/4 watt		

5-1. The low frequency oscillator is a multivibrator type of oscillator with a tuned LC network in the base of the second stage Q102. Four controls tune the LC network:

a. 0-100 KHZ capacitor C1646 which functions as the main tubing control.

b. CALIBRATION control capacitor C1647 which sets the circuit to the 5 KHZ calibration points.

c. High and low dial tracking controls capacitor C1645 and coil L101.

5-2. TYPICAL VOLTAGES.

a. The 400 to 500 KHZ output to the buffer amplifier (measured at C104) should be approximately 1.5 volts peak-to-peak.

b. The signal to the main lock phase detector (measured at the junction of C106 and C107) should be approximately 0.1 volt peak-to-peak.

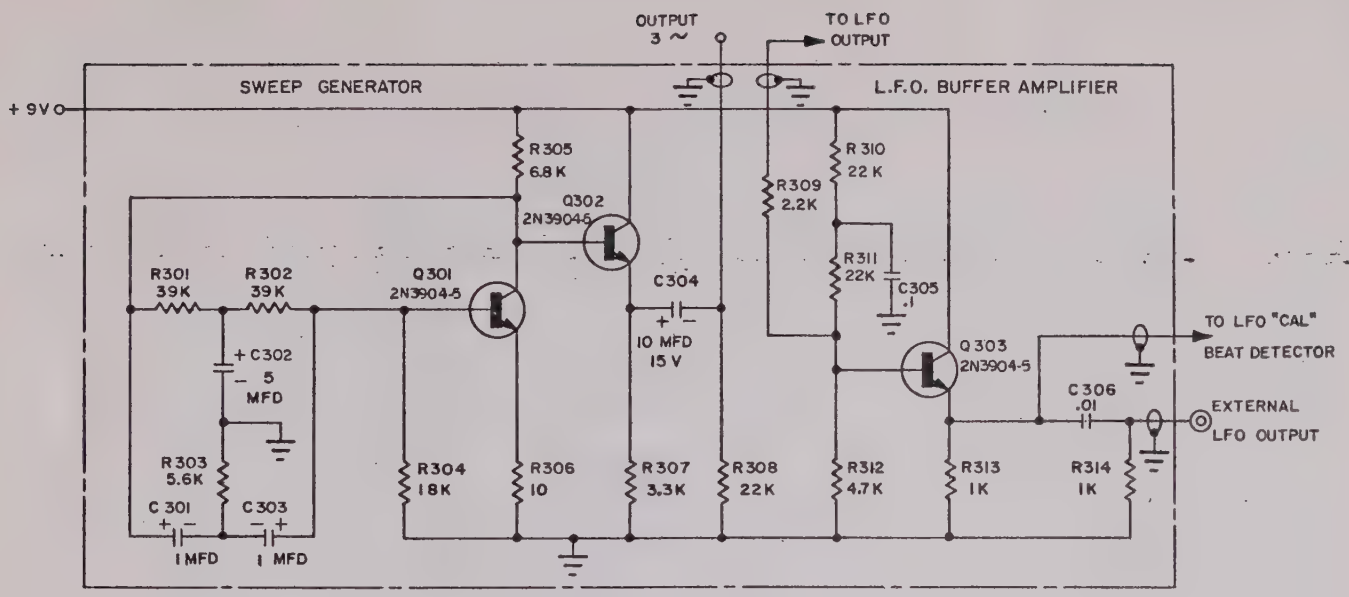
6-1. The discriminator receives a signal from amplifier and limiter A1602 and delivers a dc voltage to the meter with an amplitude determined by frequency deviation. The unit also delivers demodulated audio to the discriminator output (scope) jack and to the head phone jack.

6-2. The input signal is applied to the two sides of the discriminator through transistors Q201 and Q202. The low side Q201 is tuned to 270 KHZ and the high side Q202 is tuned to 330 KHZ. The outputs of the two transistors are applied to peak-to-peak detectors (CR201, CR202, CR203, CR204). The rectifier circuit is referenced to a dc level by potentiometer R210.

6-3. At the center frequency of 300 KHZ, the signals developed by the two sides are equal and therefore the audio output of the circuit is zero. As the frequency deviates, one side or the other will develop a greater signal and therefore an audio output. The amplitude of audio signal is determined by the amount of deviation from the center frequency. The audio output is delivered to the audio circuits through emitter follower Q203. The audio signal is delivered to the discriminator output jacks J1603 and J1604 through resistor R233.

6-4. A three stage audio amplifier consisting of transistors Q204, Q205, and Q206 is used to drive the voltmeter circuits. Direct coupling is used between stages and degenerative feedback stabilizes gain. The voltmeter circuit is calibrated by setting the gain through the amplifier. Potentiometer R226 calibrates the meter for a full scale indication of 5 KHZ, potentiometer R224 calibrates the meter for 15 KHZ, and potentiometer R238 calibrates the meter for 1.5 KHZ.

6-5. Two peak reading voltmeter circuits are included for detection of upper and lower side bands. Capacitor C219 is charged positive to a peak value through diode CR207 and slowly discharges through resistor R232. Capacitor C218 is charged negative through diode CR208 and slowly discharges through resistor R230. Either circuit may be connected to the meter by deviation switch S1605.



NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ±10% 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.

Figure 7-1. Schematic (Sweep Generator and Buffer)

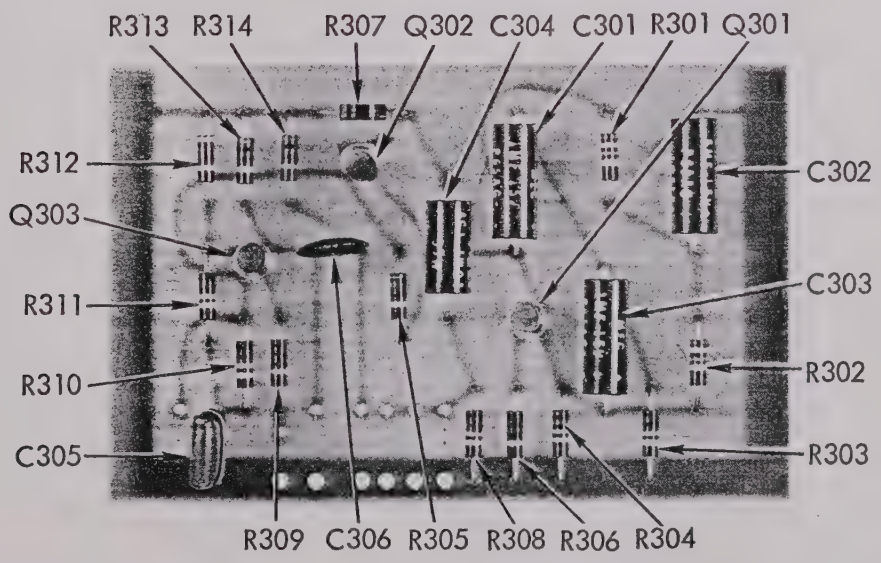
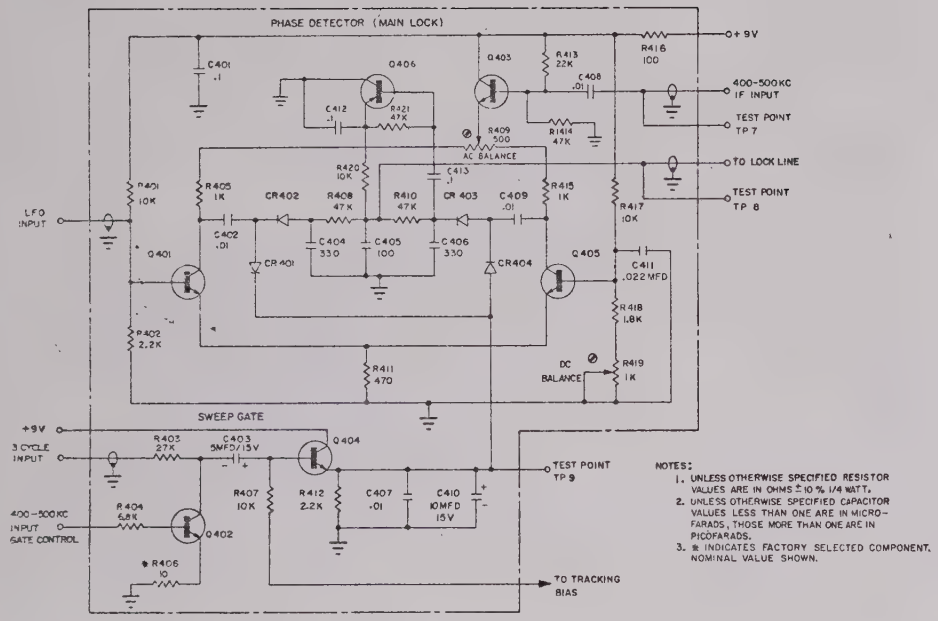


Figure 7-2. Component Location (Sweep Generator and Buffer)

REF DESIG	ITEM	PART NO.	MFR
C301	Capacitor, electrolytic, 1 uf, 15 V	P65AG-10115	MEC
C302	Capacitor, electrolytic, 5 uf, 15 vdc	P65AG-10515	MEC
C303	Capacitor, electrolytic, 1 uf, 15 vdc	P65AG-10115	MEC
C304	Capacitor, electrolytic, 10 uf, 15 vdc	P65AG-101015	MEC
C305	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C306	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
Q301	Transistor	2N3904	
Q302	Transistor	2N3904	
Q303	Transistor	2N3904	
R301	Resistor, composition, 39K ±10%, 1/4 watt		
R302	Resistor, composition, 39K ±10%, 1/4 watt		
R303	Resistor, composition, 5.6K ±10%, 1/4 watt		
R304	Resistor, composition, 18K ±10%, 1/4 watt		
R305	Resistor, composition, 6.8K ±10%, 1/4 watt		
R306	Resistor, composition, 10 ohms ±10%, 1/4 watt		
R307	Resistor, composition, 3.3K ±10%, 1/4 watt		
R308	Resistor, composition, 22K ±10%, 1/4 watt		
R309	Resistor, composition, 2.2K ±10%, 1/4 watt		
R310	Resistor, composition, 22K ±10%, 1/4 watt		
R311	Resistor, composition, 22K ±10%, 1/4 watt		
R312	Resistor, composition, 4.7K ±10%, 1/4 watt		
R313	Resistor, composition, 1K ±10%, 1/4 watt		
R314	Resistor, composition, 1K ±10%, 1/4 watt		

7-1. The sweep generator and buffer supplies the sweep voltage to assist the phase detectors in locating locks and a buffer for the auxiliary LFO outputs.

7-2. Sweep generator Q301 is a phase shift type of oscillator which supplies a very low frequency (approximately three cycles) signal. The signal is applied to the load through emitter follower Q302.



NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ±10% 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.
3. * INDICATES FACTORY SELECTED COMPONENT. NOMINAL VALUE SHOWN.

Figure 8-1. Schematic (Phase Detector and Sweep Gate)

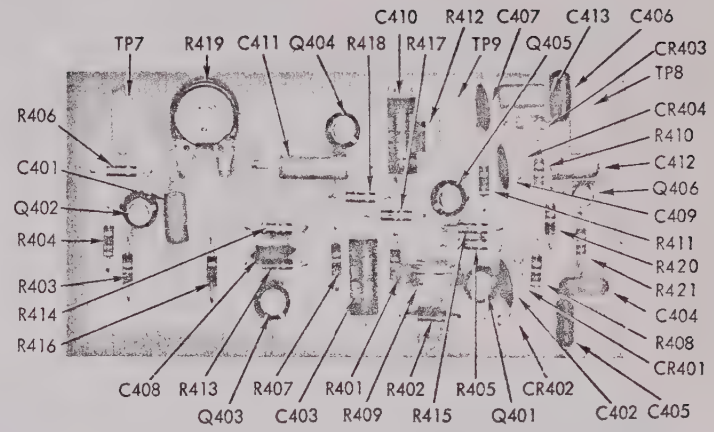


Figure 8-2. Component Location (Phase Detector and Sweep Gate)

REF DESIG	ITEM	PART NO.	MFR
C401	Capacitor, 0.1 uf	C280AA/P100K	Amperex
C402	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C403	Capacitor, 5 uf, 15 vdc	P65AG10515	MEC
C404	Capacitor, mica, 330 pf	DM15E331J	Elmenco
C405	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C406	Capacitor, mica, 330 pf	DM15E331J	Elmenco
C407	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C408	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C409	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C410	Capacitor, electrolytic, 10 uf, 15 v	P65AG101015	MEC
C411	Capacitor, mylar, 0.022 uf, 200 v	192P22392	Sprague
C412	Capacitor, 0.1 uf	C280AA/P100K	Amperex
C413	Capacitor, 0.1 uf	C280AA/P100K	Amperex
CR401	Diode	1N273	
CR402	Diode	1N273	
CR403	Diode	1N273	
CR404	Diode	1N273	
Q401	Transistor	2N3904	
Q402	Transistor	2N3904	
Q403	Transistor	2N3904	
Q404	Transistor	2N3904	
Q405	Transistor	2N3904	
Q406	Transistor	2N3904	
R401	Resistor, composition, 10K ±10%, 1/4 watt		
R402	Resistor, composition, 2.2K ±10%, 1/4 watt		
R403	Resistor, composition, 27K ±10%, 1/4 watt		
R404	Resistor, composition, 6.8K ±10%, 1/4 watt		
R405	Resistor, composition, 1K ±10%, 1/4 watt		
R406	Resistor, composition, 10 ohms ±10%, 1/4 watt (nominal)		
R407	Resistor, composition, 10K ±10%, 1/4 watt		
R408	Resistor, composition, 47K ±10%, 1/4 watt		
R409	Resistor, variable, 500 ohms	MTC-1-500	Mallory
R410	Resistor, composition, 47K ±10%, 1/4 watt		
R411	Resistor, composition, 22K ±10%, 1/4 watt		
R412	Resistor, composition, 2.2K ±10%, 1/4 watt		
R413	Resistor, composition, 22K ±10%, 1/4 watt		
R414	Resistor, composition, 47K ±10%, 1/4 watt		
R415	Resistor, composition, 1K ±10%, 1/4 watt		
R416	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R417	Resistor, composition, 10K ±10%, 1/4 watt		
R418	Resistor, composition, 1.8K ±10%, 1/4 watt		
R419	Resistor, variable, 1K	MTC-4-1K	Mallory
R420	Resistor, composition, 10K ±10%, 1/4 watt		
R421	Resistor, composition, 47K ±10%, 1/4 watt		
TP7	Test Point	119437-H	Ucinite
TP8	Test Point	119437-H	Ucinite
TP9	Test Point	119437-H	Ucinite

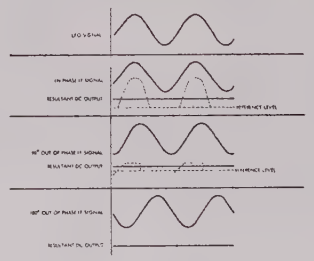


Figure 8-3. Phase Detector Waveforms

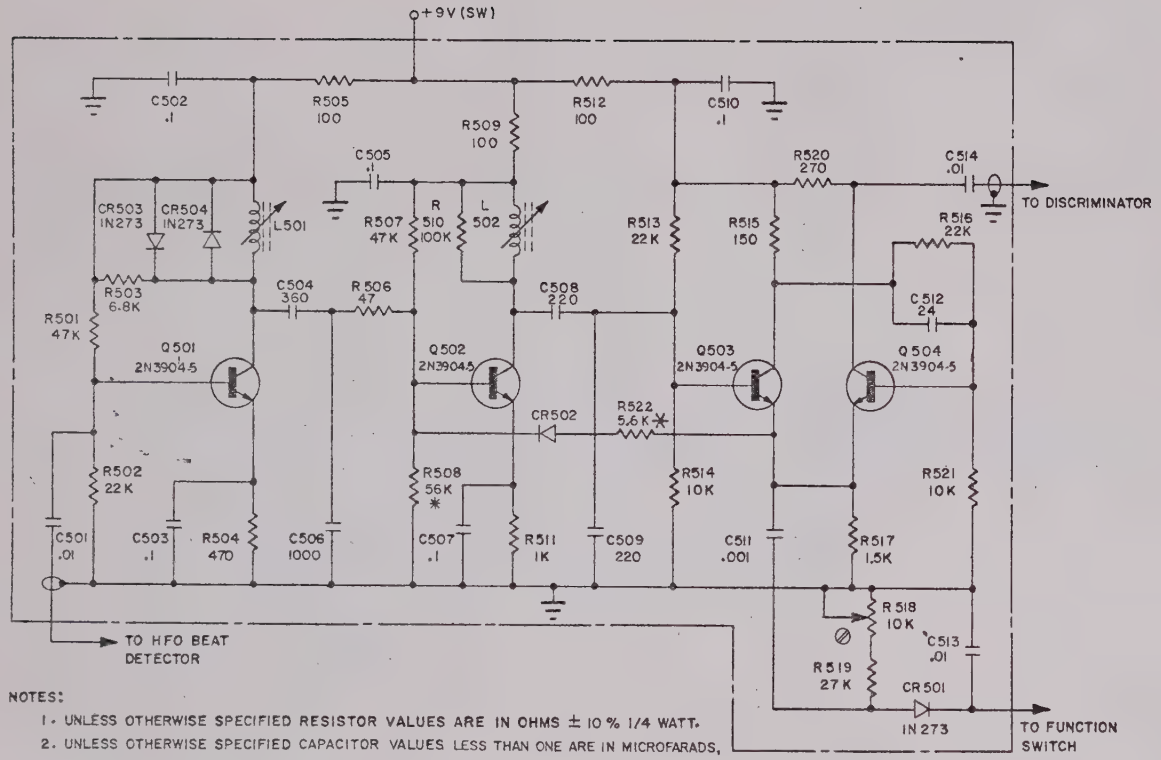
8-1. The phase detector receives a 400 to 500 KHZ signal from the 400 to 500 KHZ IF and from the low frequency oscillator. The two signals are compared and deliver a dc tuning voltage to the high frequency oscillator. To assist in locating locks, three additional inputs are supplied through the sweep gate.

8-2. The LFO signal is applied directly to the diode circuit through Q401. As a result of the common collector circuit, the signal applied through Q405 to the other side of the diode circuit is inverted 180°. Diodes CR402 and CR403 form peak-to-peak detectors, similar to the deviation meter discriminator (see Section 6). Dc filtering is provided by resistors R408 and R410 and capacitors C404, C405, and C406. The rectifier is referenced to a dc level by the sweep gate circuit.

8-3. The 400 to 500 KHZ from the IF amplifier A1613 is applied to the phase detector through emitter-follower Q403. The dc output level of the phase detector is determined by the phase relationship of the two input signals as shown in figure 8-3. As long as the phase relations remain stationary, the dc output level will remain stationary. If either signal drifts in frequency, the phase relations will change and the dc output level will change. This change in dc level results in a retuning of the HFO.

8-4. To assist the phase detector in locating a lock, a tracking bias voltage is applied as a dc reference voltage through Q404. The voltage is supplied from divider network R1604 through R1614.

8-5. To further assist in locating locks, a three cycle sweep voltage is also applied through transistor Q404. When lock is achieved, the IF signal into the phase detector will be between 400 and 500 KHZ. IF detector Q1304 will develop a dc output large enough to allow Q402 to conduct. When Q402 conducts, the three cycle sweep voltage is effectively eliminated.



NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ± 10 % 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.
3. * INDICATES FACTORY SELECTED VALUE.

Figure 9-1. Schematic (300KC Amplifier and Limiter)

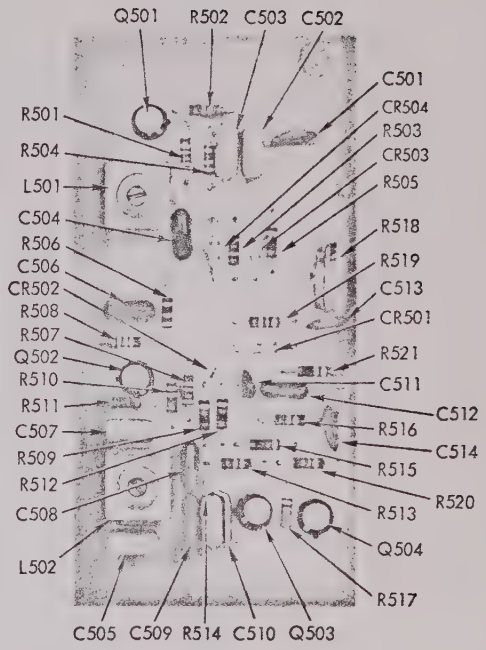


Figure 9-2. Component Location (300KC Amplifier and Limiter)

REF DESIG	ITEM	PART NO.	MFR
C501	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C502	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C503	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C504	Capacitor, mica, 360 pf	DM15E361J	Elmenco
C505	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C506	Capacitor, mica, 1000 pf	DM15E102J	Elmenco
C507	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C508	Capacitor, mica, 220 pf	DM15E221J	Elmenco
C509	Capacitor, mica, 220 pf	DM15E221J	Elmenco
C510	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C511	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C512	Capacitor, mica, 24 pf	DM15E240J	Elmenco
C513	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C514	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
CR501	Diode	1N273	
CR502	Diode	1N4148	
CR503	Diode	1N273	
CR504	Diode	1N273	
L501	Coil	387-1300	Wells Electronics
L502	Coil	387-1300	Wells Electronics
Q501	Transistor	2N3904	
Q502 thru Q504	Transistor	2N3904	
R501	Resistor, composition, 47K ±10%, 1/4 watt		
R502	Resistor, composition, 22K ±10%, 1/4 watt		
R503	Resistor, composition, 6.8K ±10%, 1/4 watt		
R504	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R505	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R506	Resistor, composition, 47 ohms ±10%, 1/4 watt		
R507	Resistor, composition, 47K ±10%, 1/4 watt		
R508	Resistor, composition, 56K ±10%, 1/4 watt		
R509	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R510	Resistor, composition, 100K ±10%, 1/4 watt		
R511	Resistor, composition, 1K ±10%, 1/4 watt		
R512	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R513	Resistor, composition, 22K ±10%, 1/4 watt		
R514	Resistor, composition, 10K ±10%, 1/4 watt		
R515	Resistor, composition, 150 ohms ±10%, 1/4 watt		
R516	Resistor, composition, 22K ±10%, 1/4 watt		
R517	Resistor, composition, 1.5K ±10%, 1/4 watt		
R518	Resistor, variable, 10K	MTC-1-10K	Mallory
R519	Resistor, composition, 27K ±10%, 1/4 watt		
R520	Resistor, composition, 270 ohms ±10%, 1/4 watt		
R521	Resistor, composition, 10K ±10%, 1/4 watt		
R522	Resistor, composition, 5.6K ±10%, 1/4 watt		

9-1. When the instrument is setup for deviation meter operation, the amplifier and limiter receives a signal with a 300 KHZ center frequency from the beat detector. The unit delivers an amplified and limited signal to the discriminator.

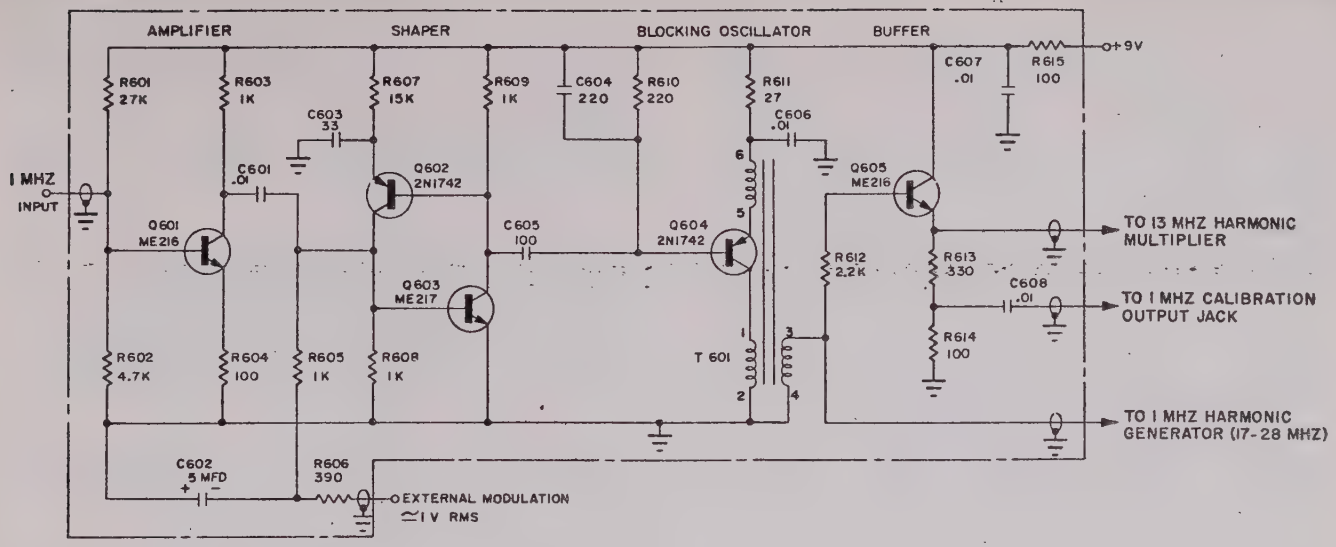
9-2. The two amplifiers Q501 and Q502 are stagger tuned (L501 tuned to 270 KHZ and L502 to 330 KHZ) to provide broad band amplification of a frequency modulated signal. The limiter Q503 and Q504 provides a fixed output level. The auxiliary output to the meter from diode CR501 provides a means for measuring the input level to the limiter.

9-3. TYPICAL VOLTAGES. With the unit adjusted as a deviation meter and the limiter current set to the red line, the following are typical voltages:

a. 200 mv peak-to-peak measured at the collector of Q501.

b. 4 v peak-to-peak measured at the collector of Q502.

c. 400 mv peak-to-peak measured at C514 (approximately square wave).



NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ±10 % 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.

Figure 10-1. Schematic (Spike Generator)

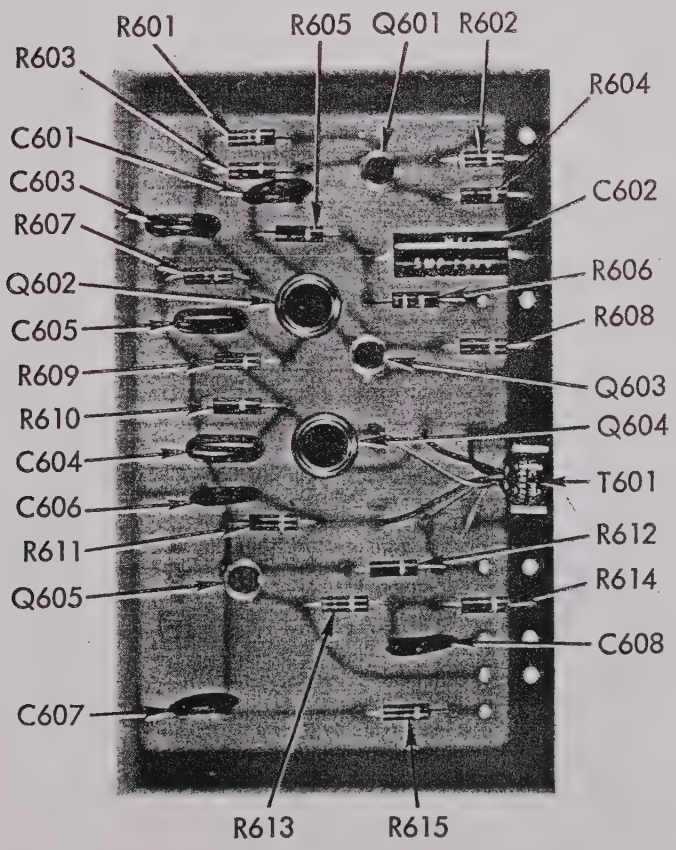


Figure 10-2. Component Location (Spike Generator)

REF DESIG	ITEM	PART NO.	MFR
C601	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C602	Capacitor, electrolytic, 5 uf, 15 vdc	P65AG-10515	MEC
C603	Capacitor, mica, 33 pf	DM15E330J	Elmenco
C604	Capacitor, mica, 220 pf	DM15E221J	Elmenco
C605	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C606	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C607	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C608	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
Q601	Transistor	2N3904	
Q602	Transistor	2N3906	
Q603	Transistor	2N3904	
Q604	Transistor	2N3906	
Q605	Transistor	2N3904	
R601	Resistor, composition, 27K ±10%, 1/4 watt		
R602	Resistor, composition, 4.7K ±10%, 1/4 watt		
R603	Resistor, composition, 1K ±10%, 1/4 watt		
R604	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R605	Resistor, composition, 1K ±10%, 1/4 watt		
R606	Resistor, composition, 390 ohms ±10%, 1/4 watt		
R607	Resistor, composition, 15K ±10%, 1/4 watt		
R608	Resistor, composition, 1K ±10%, 1/4 watt		
R609	Resistor, composition, 1K ±10%, 1/4 watt		
R610	Resistor, composition, 220 ohms ±10%, 1/4 watt		
R611	Resistor, composition, 27 ohms ±10%, 1/4 watt		
R612	Resistor, composition, 2.2K ±10%, 1/4 watt		
R613	Resistor, composition, 330 ohms ±10%, 1/4 watt		
R614	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R615	Resistor, composition, 100 ohms ±10%, 1/4 watt		
T601	Transformer	PIP-1	UTC

10-1. The spike generator receives a 1 MHZ sine wave signal from crystal oscillator assembly A1608 and delivers 1 MHZ spikes to MHZ selector assembly A1607, MHZ multiplier assembly A1605, and 1 MHZ OUTPUT connector J1606. Audio from a modulation source is converted to frequency modulation and applied through the time base to the output signal.

10-2. The incoming signal is amplified by amplifier Q601 and applied to shaper stage Q602 and Q603. Since the transistors are opposite types, the direct coupling provides positive feedback and the stage operates similar to a multivibrator. The square wave output is converted to spikes by the differentiator in the output circuit.

10-3. When audio is applied through the external modulation connector, the audio functions as a variable bias on the shaper (see figure 10-3). The change in bias affects the point in time when the shaper is triggered to the opposite state. The change in triggering time affects the time between pulses and thus effectively the pulse frequency. The amount of frequency change is determined by the amplitude of the audio input. This type of circuit is sensitive also to the frequency of the audio input. To provide a relatively constant deviation regardless of the audio frequency, RC circuit (C602 and R606) operates as a de-emphasis circuit.

10-4. The spike output of the shaper is applied to blocking oscillator Q604. The blocking oscillator provides output pulses with sharp rise and fall characteristics. The output of the blocking oscillator is applied directly to the MHZ selector and through buffer Q605 to the MHZ multiplier and the output connector.

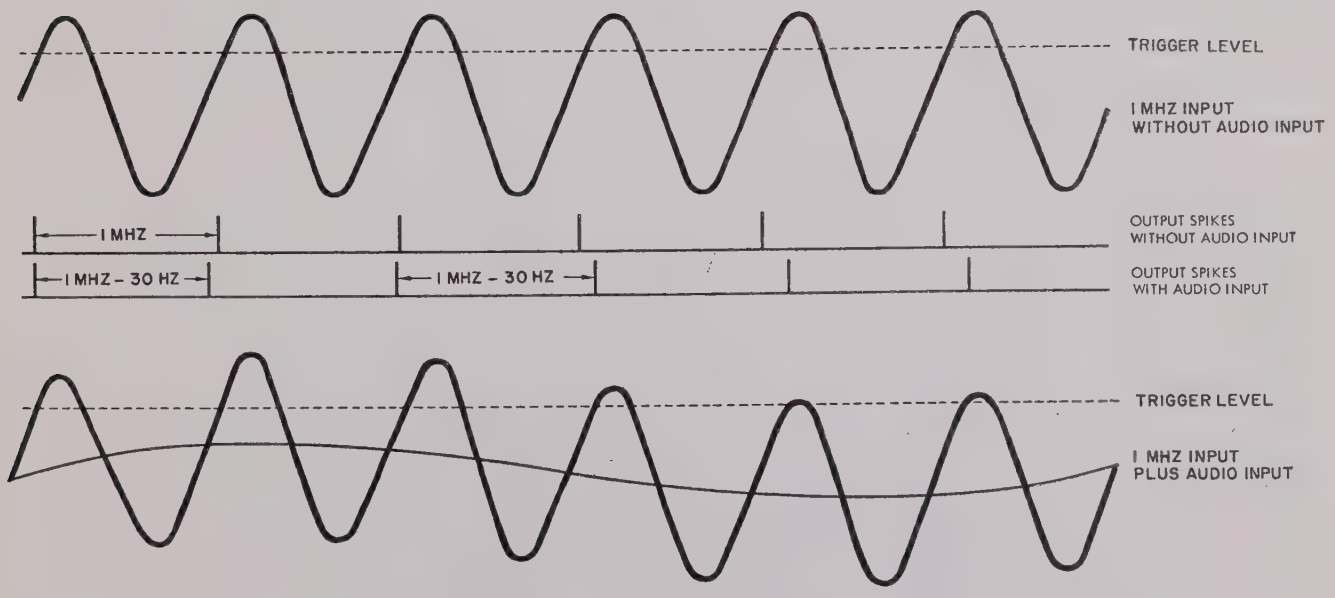
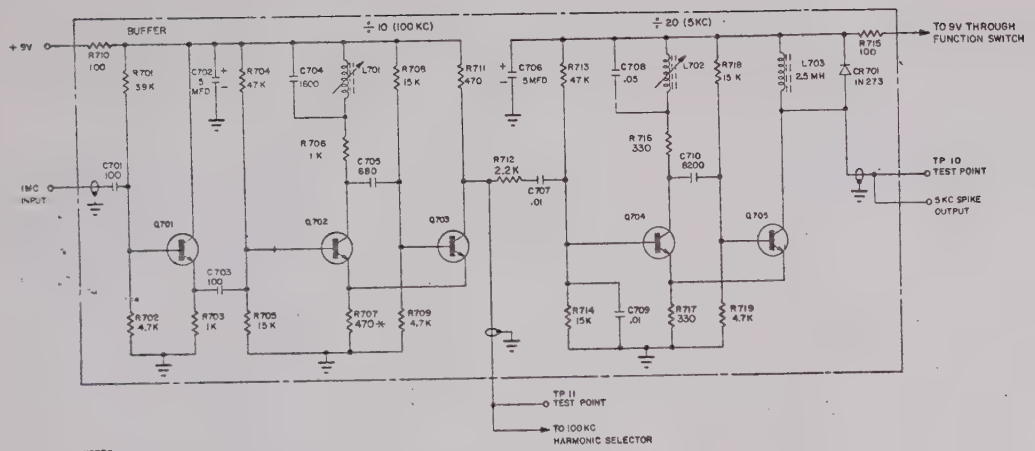


Figure 10-3. Modulation Circuit Waveforms



NOTES

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ±10% 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.
3. INDICATES FACTORY SELECTED VALUE *
4. ALL TRANSISTORS ARE TYPE 2N3904-5

Figure 11-1. Schematic (Frequency Dividers)

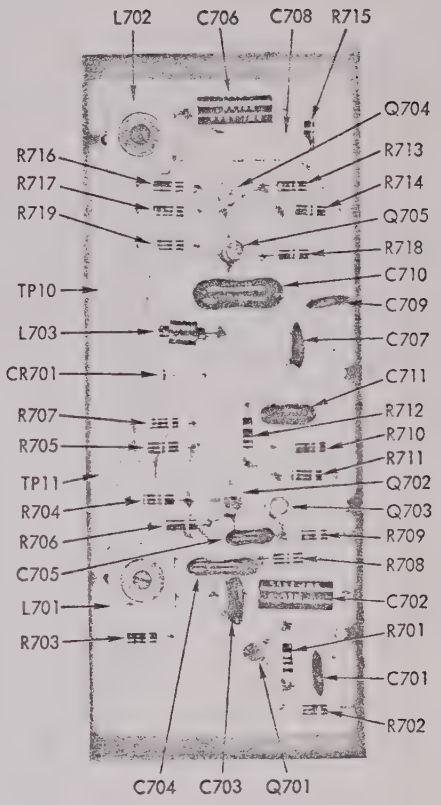


Figure 11-2. Component Location (Frequency Dividers)

REF DESIG	ITEM	PART NO.	MFR
C701	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C702	Capacitor, electrolytic, 5 uf	P65AG10515	MEC
C703	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C704	Capacitor, mica, 1600 pf	DM19E162J	Elmenco
C705	Capacitor, mica, 680 pf	DM15E681J	Elmenco
C706	Capacitor, electrolytic, 5 uf	P65A10515	MEC
C707	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C708	Capacitor, plastic, 0.05 uf	PVC215	Mallory
C709	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C710	Capacitor, mica, 8200 pf	DM30E822J	Elmenco
C711	Not Used	DM15E331J	Elmenco
CR701	Diode	1N273	
L701	Coil	387-3000	Wells
L702	Coil	387-40M	Wells
L703	Coil, 2.5 uh	70F253AI	Miller
Q701	Transistor	2N3904	
Q702 thru Q705	Transistor	2N3904	
R701	Resistor, composition, 39K ±10%, 1/4 watt		
R702	Resistor, composition, 4.7K ±10%, 1/4 watt		
R703	Resistor, composition, 1K ±10%, 1/4 watt		
R704	Resistor, composition, 47K ±10%, 1/4 watt		
R705	Resistor, composition, 15K ±10%, 1/4 watt		
R706	Resistor, composition, 1K ±10%, 1/4 watt		
R707	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R708	Resistor, composition, 15K ±10%, 1/4 watt		
R709	Resistor, composition, 4.7K ±10%, 1/4 watt		
R710	Resistor, composition, 100 ohms, ±10%, 1/4 watt		
R711	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R712	Resistor, composition, 2.2K ±10%, 1/4 watt		
R713	Resistor, composition, 47K ±10%, 1/4 watt		
R714	Resistor, composition, 15K ±10%, 1/4 watt		
R715	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R716	Resistor, composition, 330 ohms ±10%, 1/4 watt		
R717	Resistor, composition, 330 ohms ±10%, 1/4 watt		
R718	Resistor, composition, 15K ±10%, 1/4 watt		
R719	Resistor, composition, 4.7K ±10%, 1/4 watt		
TP10	Test Point	119437-H	Ucinite
TP11	Test Point	119437-H	Ucinite

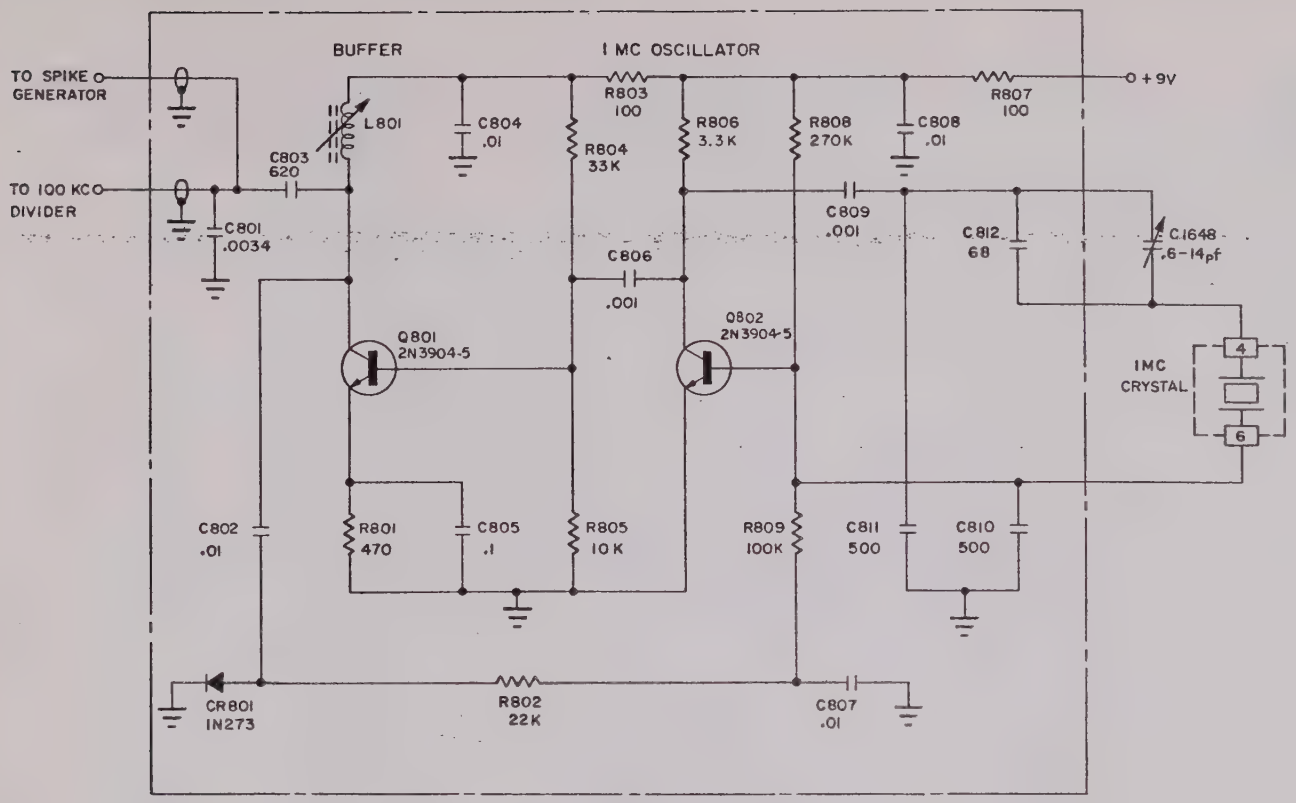
11-1. The frequency divider receives a 1 MHZ signal from the crystal oscillator and delivers a 100 KHZ signal to the 100 KHZ selector A1610 and a 5 KHZ signal to audio A1606.

11-2. The 1 MHZ signal is applied through buffer Q701 to the divide-by-ten circuit Q702 and Q703. The divider is a multivibrator tuned by coil L701 to be synchronized when the tenth input sine wave is applied. The divide-by-twenty circuit Q704 and Q705 is similar except that the circuit is tuned by coil L702 to be synchronized when the twentieth input sine wave is applied.

11-3. TYPICAL VOLTAGES. With a 0.8 to 1.0 v peak-to-peak input at C701, the following are typical voltages:

a. 3 v peak-to-peak measured at test point TP11. The waveform should be a partially-squared sine wave.

b. 8 v peak-to-peak spikes 5 KHZ measured at TP10.



NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ±10% 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.

Figure 12-1. Schematic (Crystal Oscillator)

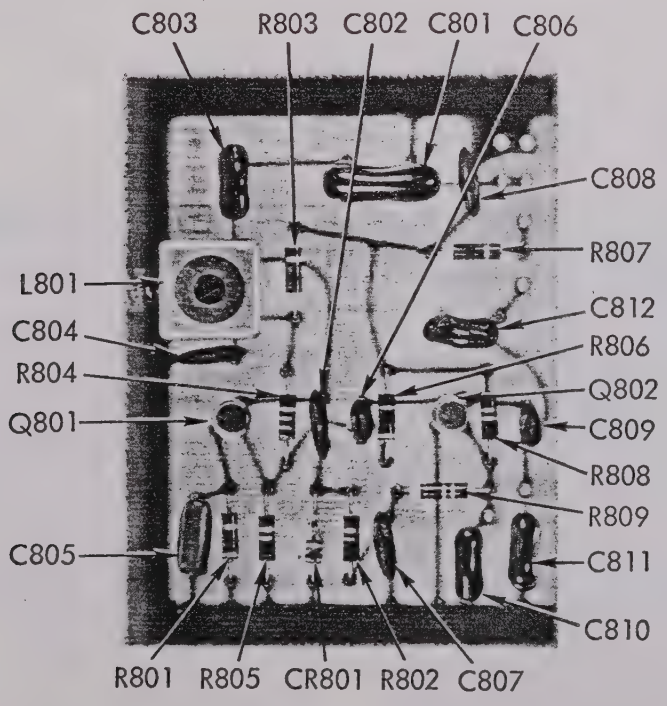


Figure 12-2. Component Location (Crystal Oscillator)

REF DESIG	ITEM	PART NO.	MFR
C801	Capacitor, mica, 0.0033 uf	DM19E332J	Elmenco
C802	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C803	Capacitor, mica, 620 pf	DM15E621J	Elmenco
C804	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C805	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C806	Capacitor, ceramic disc	861Z5U102Z	Erie
C807	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C808	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C809	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C810	Capacitor, mica, 500 pf	DM15E501J	Elmenco
C811	Capacitor, mica, 500 pf	DM15E501J	Elmenco
C812	Capacitor, 68 pf	TCZ-68	Centralab
CR801	Diode	1N273	
L801	Choke	387-60	Wells
Q801	Transistor	2N3904	
Q802	Transistor	2N3904	
R801	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R802	Resistor, composition, 22K ±10%, 1/4 watt		
R803	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R804	Resistor, composition, 33K ±10%, 1/4 watt		
R805	Resistor, composition, 10K ±10%, 1/4 watt		
R806	Resistor, composition, 3.3K ±10%, 1/4 watt		
R807	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R808	Resistor, composition, 270K ±10%, 1/4 watt		
R809	Resistor, composition, 100K ±10%, 1/4 watt		

12-1. The crystal oscillator supplies a stable, accurate 1 MHZ signal to spike generator assembly A1608 and to frequency divider assembly A1612.

12-2. The oscillator Q802 is a modified Pierce circuit designed for stable performance regardless of supply voltage changes. The oscillator is isolated from the load by buffer Q801. The buffer supplies a rectified (CR801) AGC voltage to the oscillator through resistors R802 and R809 and capacitor C807. The buffer is tuned by coil L801. The crystal is adjusted to frequency by MHZ ADJ capacitor C1648.

12-3. The output of the crystal oscillator (measured at C801) should be between 0.8 and 1.0 volts peak-to-peak.

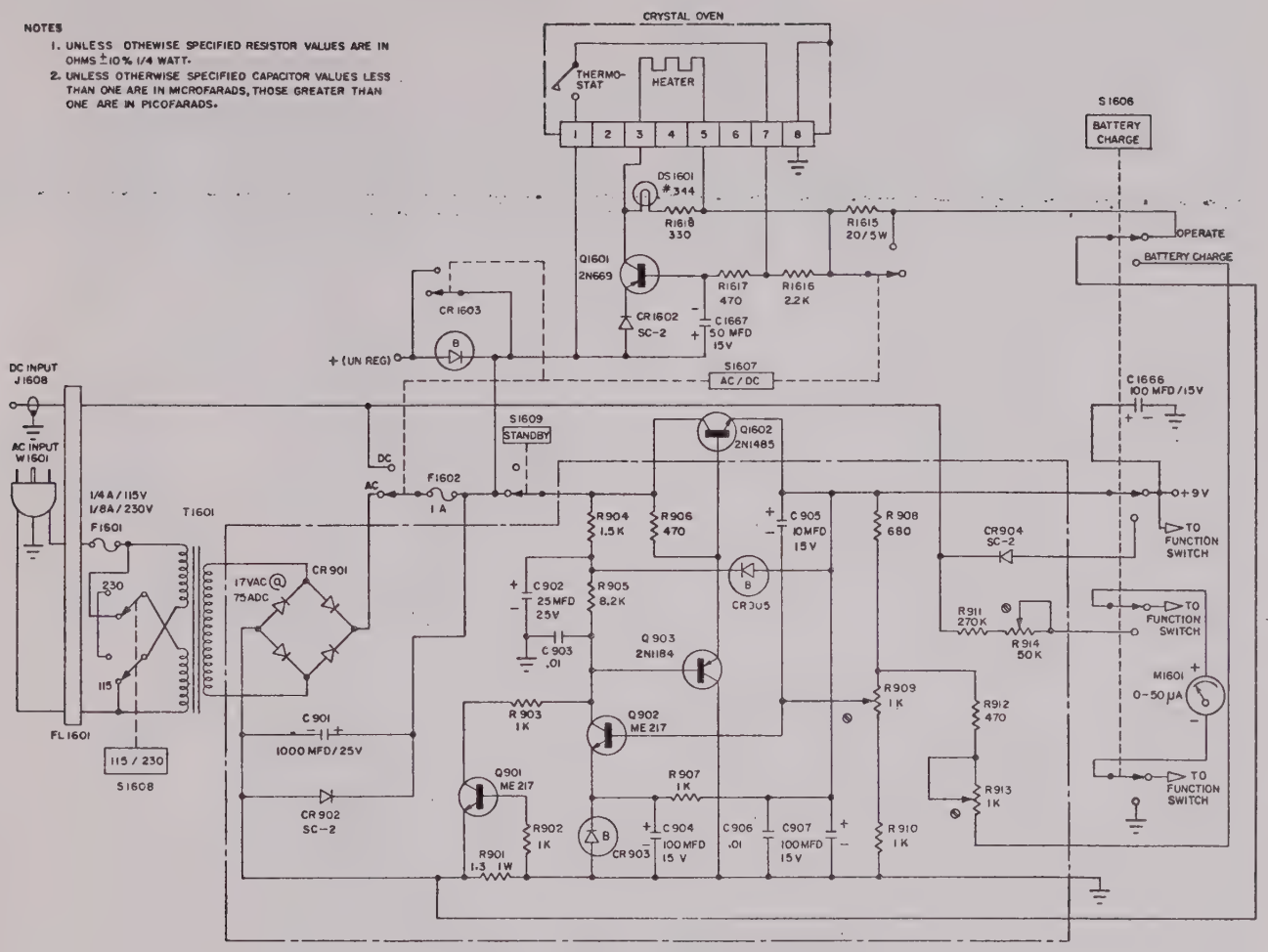


Figure 13-1. Schematic (Power Supply)

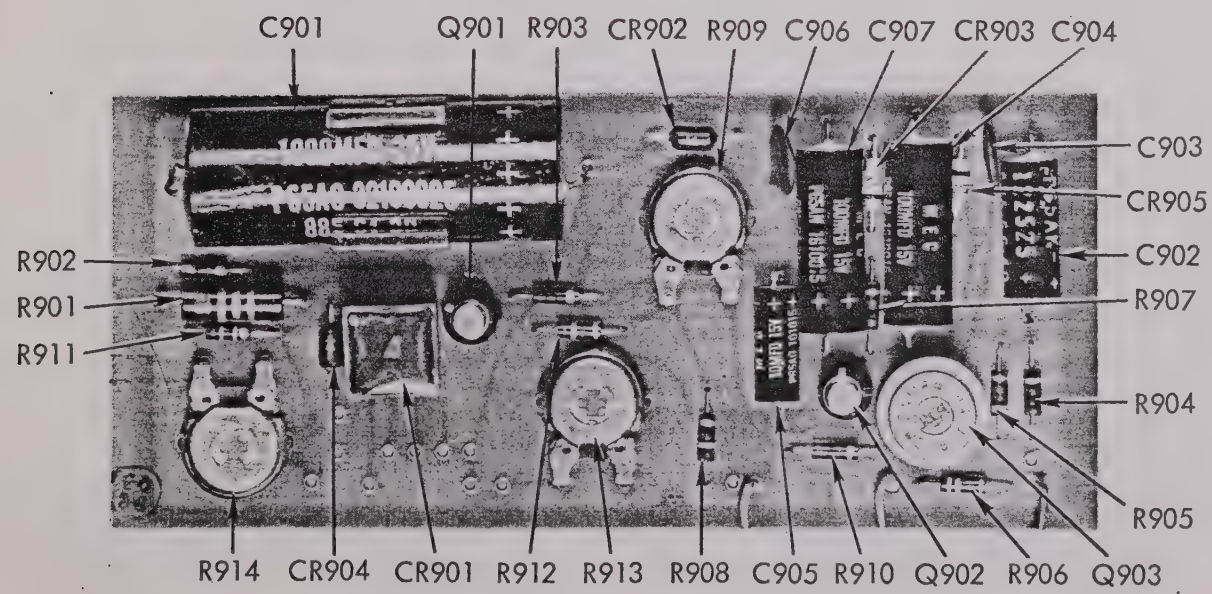


Figure 13-2. Component Location (Power Supply)

REF DESIG	ITEM	PART NO.	MFR
C901	Capacitor, electrolytic, 1000 uf, 25 vdc	P65AS32100025	MEC
C902	Capacitor, electrolytic, 25 uf, 25 vdc	P65AG122525	MEC
C903	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C904	Capacitor, electrolytic, 100 uf, 15 vdc	P65AN1610015	MEC
C905	Capacitor, electrolytic, 10 uf, 15 vdc	P65AG101015	MEC
C906	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C907	Capacitor, electrolytic, 100 uf, 15 vdc	P65AN1610015	MEC
CR901	Diode Bridge	5199	Diodes, Inc.
CR902	Diode	SC-2	Semtech
CR903	Diode, Zener	1N705	
CR904	Diode	SC-2	Semtech
CR905	Diode, Zener	1N705	
Q901	Transistor	2N3904	
Q902	Transistor	2N3904	
Q903	Transistor	2N4234	
R901	Resistor, composition, 1.3 ohms ±10%, 1 watt		
R902	Resistor, composition, 1K ±10%, 1/4 watt		
R903	Resistor, composition, 10 ohms ±10%, 1/4 watt		
R904	Resistor, composition, 1.5K ±10%, 1/4 watt		
R905	Resistor, composition, 8.2K ±10%, 1/4 watt		
R906	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R907	Resistor, composition, 1K ±10%, 1/4 watt		
R908	Resistor, composition, 680 ohms ±10%, 1/4 watt		
R909	Resistor, variable, 1K	MTC-4-1K	Mallory
R910	Resistor, composition, 1K ±10%, 1/4 watt		
R911	Resistor, composition, 270K ±10%, 1/4 watt		
R912	Resistor, composition, 680 ohms ±10%, 1/4 watt		
R913	Resistor, variable, 1K	MTC-4-1K	Mallory
R914	Resistor, variable, 50K	MTC-4-50K	Mallory

13-1. The power supply provides 9 vdc regulated and 12 vdc unregulated power for normal operation or 12 to 15 vdc power for battery charge.

13-2. When ac power is used, the power is converted to dc by the power supply (transformer T1601 and rectifier bridge CR901). When 115/230 switch is turned to the 115 position, the dual primaries of transformer T1601 are placed in parallel. With the switch in the 230 position, the primaries are placed in series.

13-3. Either rectified ac or a dc input is filtered and regulated in the power supply. Transistor Q1602 is the series element and transistor Q902 provides dc error amplification. Transistor Q902 is referenced by Zener diode CR903 and the error signal is applied through transistor Q903. Potentiometer R909 sets the output voltage to 9 vdc when the battery charge switch S1606 is turned to the OPERATE position. With the switch in the BATTERY CHARGE position, potentiometer R913 is placed in parallel with R909 and sets output voltage to approximately 15 vdc.

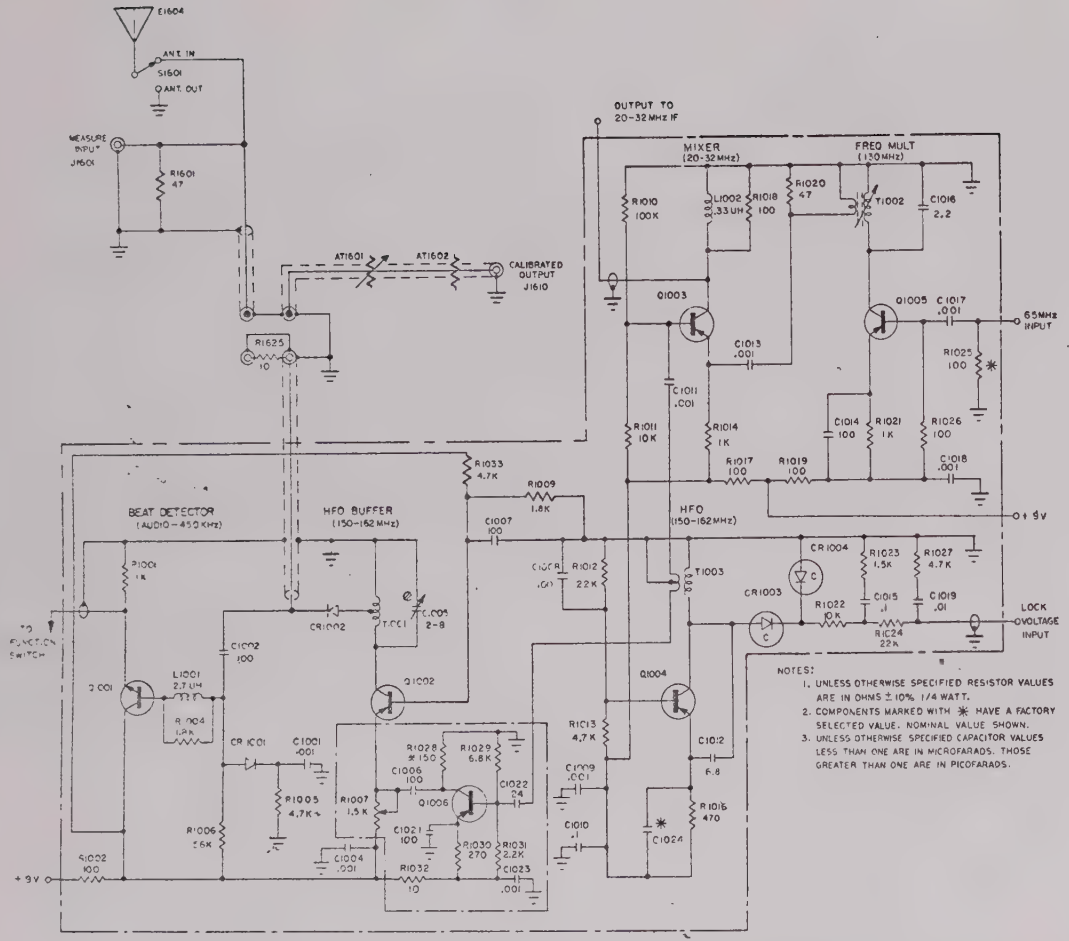


Figure 14-1. Schematic (High Frequency Oscillator)

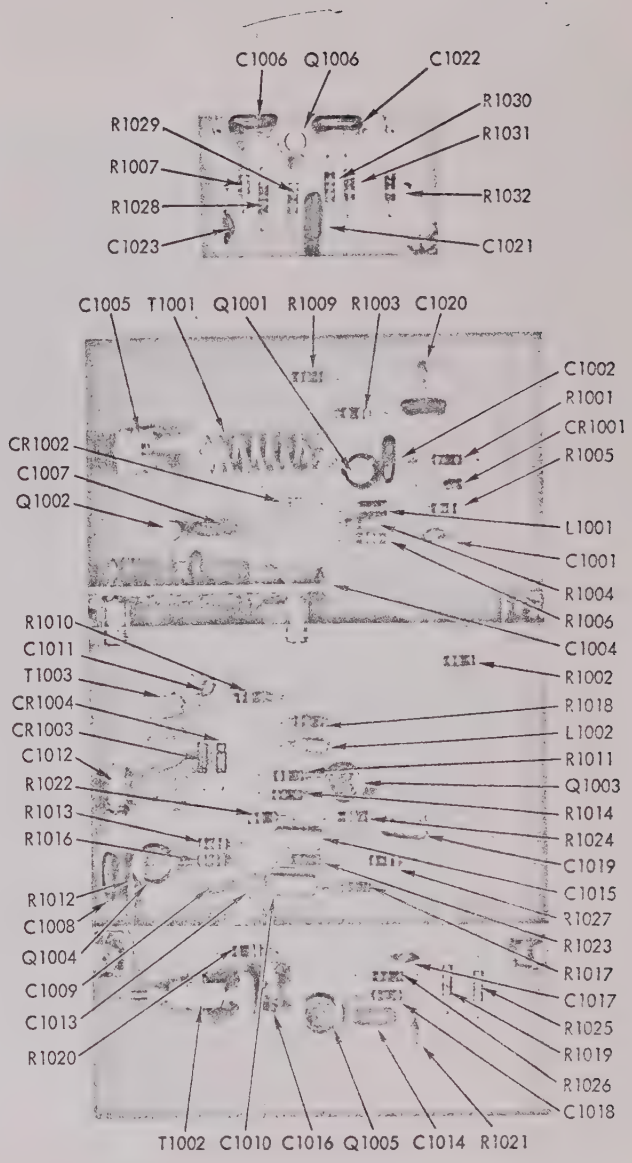


Figure 14-2. Component Location (High Frequency Oscillator)

REF DESIG	ITEM	PART NO.	MFR
C1001	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1002	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1004	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1005	Capacitor, trimmer, 2 to 8 pf	538-006NP02-8	Erie
C1006	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1007	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1008	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1009	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1010	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1011	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1012	Capacitor, 6.8 pf	TCZ-6.8	Centralab
C1013	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1014	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1015	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1016	Capacitor, 2.2 pf	TCZ-2R2	Centralab
C1017	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1018	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1019	Capacitor, mylar, 0.01 uf	C280AA/P10K	Amperex
C1020	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1021	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1022	Capacitor, mica, 24 pf	DM15E240J	Elmenco
C1023	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
CR1001	Diode	1N4148	
CR1002	Diode	1N273	
CR1003	Diode, capacitive reactance	SC2	Transitron
CR1004	Diode, capacitive reactance	SC2	Transitron
L1001	Coil, 2.7 uh	70F276A1	Miller
L1002	Coil, 0.33 uh	DDO-33	Nytronics
Q1001	Transistor	2N3904	

REF DESIG	ITEM	PART NO.	MFR
Q1002	Transistor	2N3283	
Q1003	Transistor	2N3283	
Q1004	Transistor	2N3283	
Q1005	Transistor	2N3283	
Q1006	Transistor	2N3283	
R1001	Resistor, composition, 1K ±10%, 1/4 watt		
R1002	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1004	Resistor, composition, 1.8K ±10%, 1/4 watt		
R1005	Resistor, composition, 4.7K ±10%, 1/4 watt		
R1006	Resistor, composition, 56K ±10%, 1/4 watt		
R1007	Resistor, variable, 1.5K ±10%, 1/4 watt	330PC15282	
R1009	Resistor, composition, 1.8K ±10%, 1/4 watt		
R1010	Resistor, composition, 100K ±10%, 1/4 watt		
R1011	Resistor, composition, 10K ±10%, 1/4 watt		
R1012	Resistor, composition, 22K ±10%, 1/4 watt		
R1013	Resistor, composition, 4.7K ±10%, 1/4 watt		
R1014	Resistor, composition, 150K ±10%, 1/4 watt		
R1016	Resistor, composition, 330 ohms ±10%, 1/4 watt		
R1017	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1018	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1019	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1020	Resistor, composition, 47 ohms ±10%, 1/4 watt		
R1021	Resistor, composition, 1K ±10%, 1/4 watt		
R1022	Resistor, composition, 10K ±10%, 1/4 watt		
R1023	Resistor, composition, 1.5K ±10%, 1/4 watt		
R1024	Resistor, composition, 22K ±10%, 1/4 watt		
R1025	Resistor, composition, 150 ohms ±10%, 1/4 watt		
R1026	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1027	Resistor, composition, 4.7K nominal value		

REF DESIG	ITEM	PART NO.	MFR
R1028	Resistor, composition, 150 ohms ±10%, 1/4 watt		
R1029	Resistor, composition, 6.8K ±10%, 1/4 watt		
R1030	Resistor, composition, 220 ohms ±10%, 1/4 watt		
R1031	Resistor, composition, 2.2K ±10%, 1/4 watt		
R1032	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1033	Resistor, composition, 4.7K ±10%, 1/4 watt		
T1001	Transformer	EP68	Singer
T1002	Transformer	EP69	Singer
T1003	Transformer	EP70	Singer

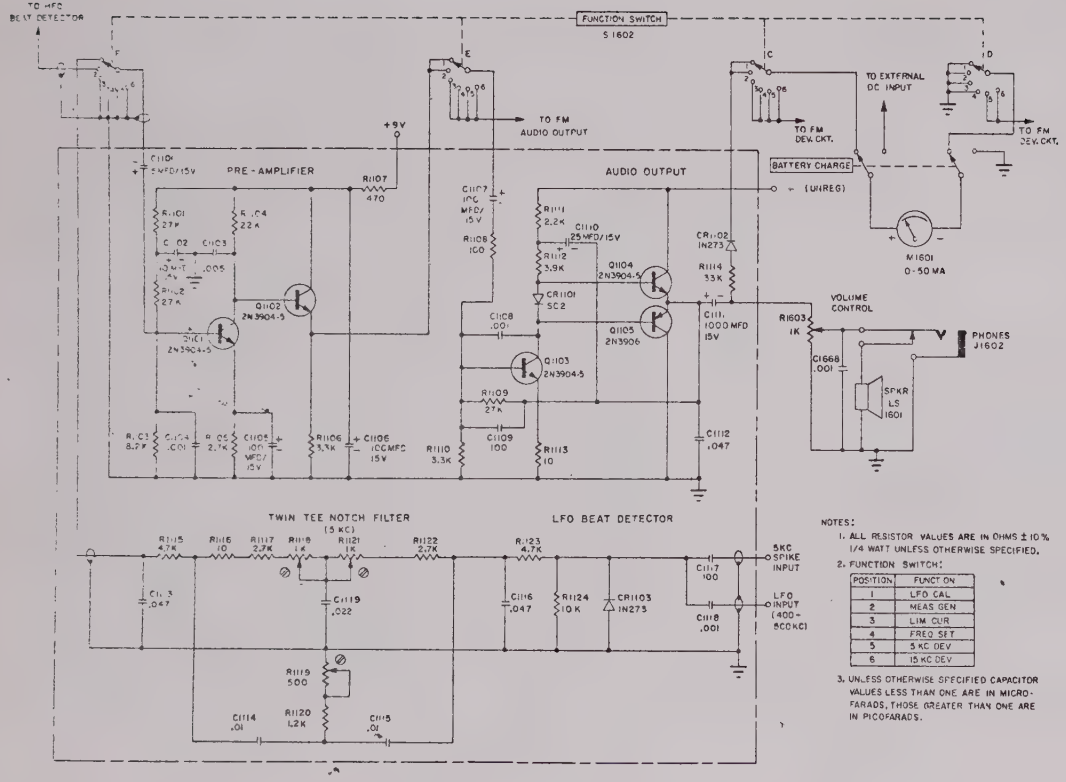
14-1. The high frequency oscillator board receives a 66 MHZ signal from megacycle oscillator A1608 and a dc tuning (lock) voltage from phase detector A1614. The HFO produces the 152 to 164 MHZ standard signal.

14-2. The 66 MHZ signal is applied to multiplier Q1005. The output circuit of the multiplier is tuned to the second harmonic (132 MHZ) by transformer T1002. The 132 MHZ output signal is applied to mixer Q1003. The 152 to 164 MHZ signal from HFO Q1004 is also applied to the mixer. The 20 to 32 MHZ difference frequency is applied to MHZ selector A1607.

14-3. The HFO Q1004 is a tuned collector oscillator which uses voltage tunable, capacitive reactance diodes CR1003 and CR1004 as the tuning elements. The lock voltage from the phase detector is applied to the diodes through a dc filter circuit. The output of the oscillator is applied through buffer Q1002 to the input/output circuit.

14-4. The output circuit of the buffer is tuned by capacitor C1005. The output of the buffer is applied through diode CR1002, operating as a harmonic generator, to the output circuit through capacitor C1003 or to beat detector Q1001 through capacitor C1002. The beat detector is designed for good response to low frequency beat notes.

14-5. Output level is set by the attenuator and by bias control of buffer Q1002. The attenuator consists of four 20 db pads which may be added in series. When the attenuator switch is turned to the antenna position, one section of the switch selects a fixed bias voltage for the buffer. In the remaining positions the bias may be varied by potentiometer R1601.



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS ± 10% 1/4 WATT UNLESS OTHERWISE SPECIFIED.
2. FUNCTION SWITCH:

POSITION	FUNCTION
1	LFO CAL
2	MEAS GEN
3	LIM CUR
4	FREQ SET
5	5 KC DEV
6	15 KC DEV

3. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE GREATER THAN ONE ARE IN PICOFARADS.

Figure 15-1. Schematic (Audio)

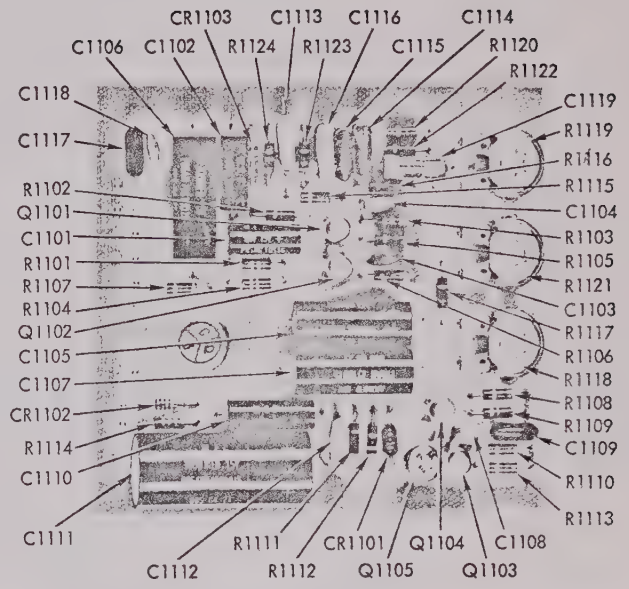


Figure 15-2. Component Location (Audio)

REF DESIG	ITEM	PART NO.	MFR
C1101	Capacitor, electrolytic, 5 uf, 15 vdc	P65AG10515	MEC
C1102	Capacitor, electrolytic, 10 uf, 15 vdc	P65AG101015	MEC
C1103	Capacitor, ceramic disc, 0.005 uf	801Z5U502Z	Erie
C1104	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1105	Capacitor, electrolytic, 100 uf, 15 vdc	P65AN1610015	MEC
C1106	Capacitor, electrolytic, 100 uf, 15 vdc	P65AN1610015	MEC
C1107	Capacitor, electrolytic, 100 uf, 15 vdc	P65AN1610015	MEC
C1108	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1109	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1110	Capacitor, electrolytic, 25 uf, 15 vdc	P65AG122515	MEC
C1111	Capacitor, electrolytic, 1000 uf, 15 vdc	P65AR24100015	MEC
C1112	Capacitor, mylar, 0.047 uf	C280AA/P47K	Amperex
C1113	Capacitor, mylar, 0.047 uf	C280AA/P47K	Amperex
C1114	Capacitor, mylar, 0.01 uf	C280AA/P10K	Amperex
C1115	Capacitor, mylar, 0.01 uf	C280AA/P10K	Amperex
C1116	Capacitor, mylar, 0.047 uf	C280AA/P47K	Amperex
C1117	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1118	Capacitor, ceramic disc, 0.001	861Z5U102Z	Erie
C1119	Capacitor, 0.022 uf	192P22392	Sprague
CR1101	Diode	SC-2	Semtech
CR1102	Diode	1N273	
CR1103	Diode	1N273	
Q1101	Transistor	2N3904	
Q1102	Transistor	2N3904	
Q1103	Transistor	2N3904	
Q1104	Transistor	2N3904	
Q1105	Transistor	2N3906	
R1101	Resistor, composition, 27K ±10%, 1/4 watt		
R1102	Resistor, composition, 27K ±10%, 1/4 watt		
R1103	Resistor, composition, 8.2K ±10%, 1/4 watt		
R1104	Resistor, composition, 22K ±10%, 1/4 watt		
R1105	Resistor, composition, 2.7K ±10%, 1/4 watt		
R1106	Resistor, composition, 3.3K ±10%, 1/4 watt		
R1107	Resistor, composition, 470 ohms ± 10%, 1/4 watt		
R1108	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1109	Resistor, composition, 27K ±10%, 1/4 watt		
R1110	Resistor, composition, 3.3K ±10%, 1/4 watt		
R1111	Resistor, composition, 2.2K ±10%, 1/4 watt		
R1112	Resistor, composition, 3.9K ±10%, 1/4 watt		
R1113	Resistor, composition, 10 ohms ±10%, 1/4 watt		
R1114	Resistor, composition, 33K ±10%, 1/4 watt		
R1115	Resistor, composition, 4.7K ±10%, 1/4 watt		
R1116	Resistor, composition, 10 ohms ±10%, 1/4 watt		
R1117	Resistor, composition, 2.7K ±10%, 1/4 watt		
R1118	Resistor, variable, 1K	MTC-4-1K	Mallory
R1119	Resistor, variable, 500 ohms	MTC-4-500	Mallory
R1120	Resistor, composition, 1.2K ±10%, 1/4 watt		
R1121	Resistor, variable, 1K	MTC-4-1K	Mallory
R1122	Resistor, composition, 2.7K ±10%, 1/4 watt		
R1123	Resistor, composition, 4.7K ±10%, 1/4 watt		
R1124	Resistor, composition, 10K ±10%, 1/4 watt		

15-1. The audio circuit receives signals from the beat detector or the discriminator and applies audio output to a speaker or the meter. The circuit can also receive 5 KHZ signals from the frequency divider and the LFO and deliver beat notes to the speaker and meter.

15-2. With the function switch S1602 in position 1, the LFO output signal is compared to harmonics of the 5 KHZ spike input in the LFO beat detector. The audible 5 KHZ component is eliminated in the twin tee notch filter. The beat notes are applied to the audio preamplifier consisting of transistors Q1101 and Q1102.

15-3. With the function switch in position 2, beat notes from beat detector Q1001 are applied to the audio preamplifier. Audio from the preamplifier or from the detector driver of the discriminator is amplified by amplifier Q1103 and push-pull amplifiers Q1104 and Q1105.

15-4. TYPICAL VOLTAGES. With the FUNCTION switch set to CAL and with a beat frequency of approximately 200 HZ (one division of the LFO dial), the following are typical voltages:

a. 5 mv peak-to-peak measured at the base of Q1101.

b. 150 mv peak-to-peak measured at the emitter of Q1102.

c. 15 v peak-to-peak measured at the emitter of Q1104.

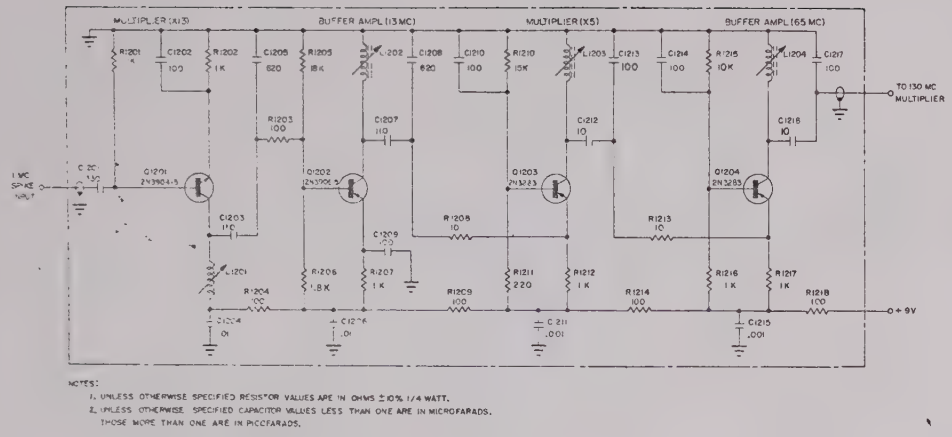

MULTIPLIER (X3)
BUFFER AMPL (13 MC)
MULTIPLIER (X5)
BUFFER AMPL (65 MC)
TO 130 MC MULTIPLIER
+ 9V
NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ±10% 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS. THOSE MORE THAN ONE ARE IN PICOFARADS.

Figure 16-1. Schematic (Megacycle Multiplier)

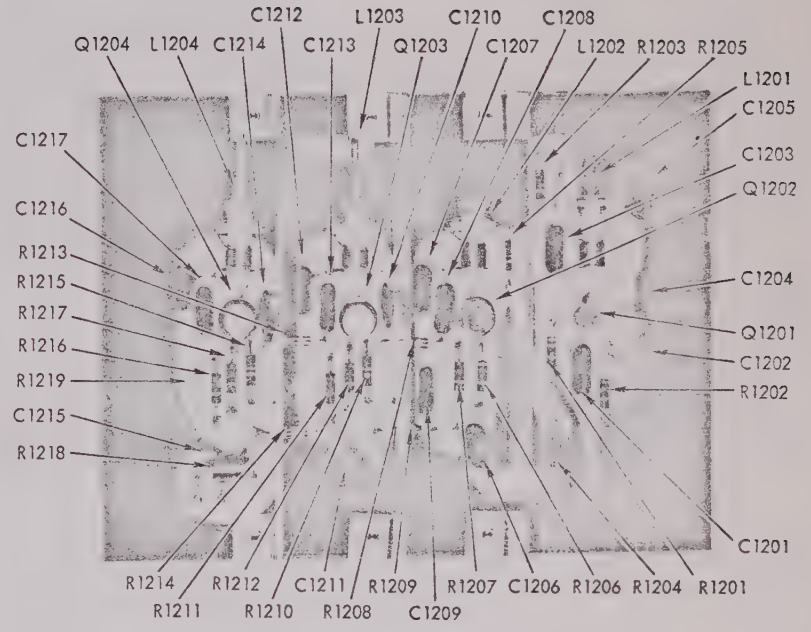
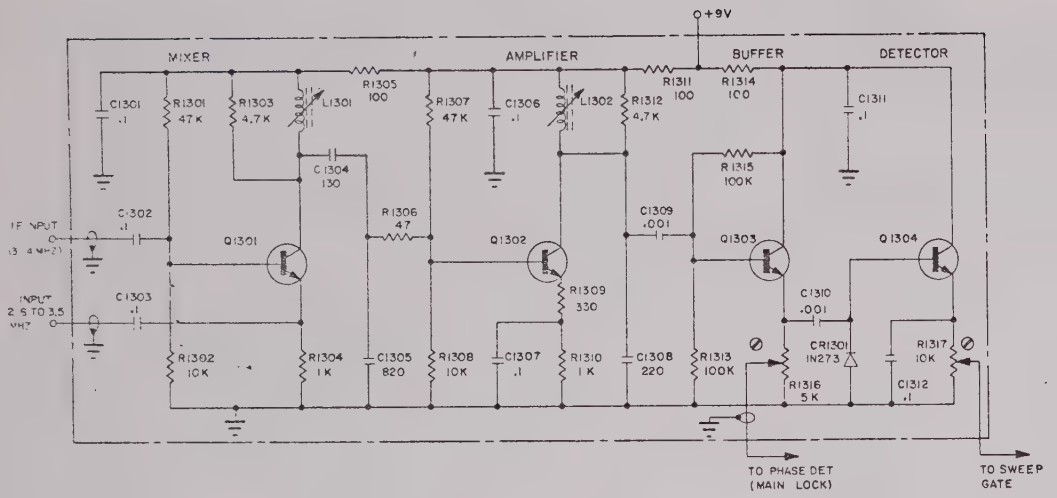


Figure 16-2. Component Location (Megacycle Multiplier)

REF DESIG	ITEM	PART NO.	MFR
C1201	Capacitor, mica, 330 pf	DM15E331J	Elmenco
C1202	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1203	Capacitor, mica, 130 pf	DM15E131J	Elmenco
C1204	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1205	Capacitor, mica, 620 pf	DM15E621J	Elmenco
C1206	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1207	Capacitor, mica, 130 pf	DM15E131J	Elmenco
C1208	Capacitor, mica, 620 pf	DM15E621J	Elmenco
C1209	Capacitor, ceramic disc, 100 pf	801Z5U101Z	Erie
C1210	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1211	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1212	Capacitor, mica, 10 pf	DM15E100J	Elmenco
C1213	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1214	Capacitor, ceramic disc, 100 pf	DM15E101J	Elmenco
C1215	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1216	Capacitor, mica, 10 pf	DM15E100J	Elmenco
C1217	Capacitor, mica, 100 pf	DM15E101J	Elmenco
L1201	Coil	3370-9	CTC
L1202	Coil	3370-9	CTC
L1203	Coil	3370-6	CTC
L1204	Coil	3370-6	CTC
Q1201	Transistor	2N3904	
Q1202	Transistor	2N3906	
Q1203	Transistor	2N3283	
Q1204	Transistor	2N3283	
R1201	Resistor, composition, 1K ±10%, 1/4 watt		
R1202	Resistor, composition, 1K ±10%, 1/4 watt		
R1203	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1204	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1205	Resistor, composition, 18K ±10%, 1/4 watt		
R1206	Resistor, composition, 1.8K ±10%, 1/4 watt		
R1207	Resistor, composition, 1K ±10%, 1/4 watt		
R1208	Resistor, composition, 10 ohms ±10%, 1/4 watt		
R1209	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1210	Resistor, composition, 15K ±10%, 1/4 watt		
R1211	Resistor, composition, 220 ohms ±10%, 1/4 watt		
R1212	Resistor, composition, 1K ±10%, 1/4 watt		
R1213	Resistor, composition, 10 ohms ±10%, 1/4 watt		
R1214	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1215	Resistor, composition, 10K ±10%, 1/4 watt		
R1216	Resistor, composition, 1K ±10%, 1/4 watt		
R1217	Resistor, composition, 1K ±10%, 1/4 watt		
R1218	Resistor, composition, 100 ohms ±10%, 1/4 watt		

16-1. The megacycle multiplier receives 1 MHZ spikes from the spike generator and delivers a 66 MHZ sine wave to high frequency oscillator board A1604.

16-2. The 1MHZ spike which is rich in harmonics is applied to multiplier Q1201. The output circuit of the multiplier is tuned to the 11tn harmonic by coil L1201. The 11 MHZ signal is amplified by buffer amplifier Q1202. This stage is tuned to 11 MHZ by coil L1202. The 11 MHZ signal is applied to multiplier Q1203, which is tuned to the 6th harmonic by coil L1203. The 66 MHZ signal is amplified by buffer-amplifier Q1203 which is tuned to 66 MHZ by coil L1204.



NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS ± 10 % 1/4 WATT.
2. UNLESS OTHERWISE SPECIFIED CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS, THOSE MORE THAN ONE ARE IN PICOFARADS.

Figure 17-1. Schematic (400 to 500 KC Mixer and Amplifier)

Figure 17-2. Component Location (400 to 500 KC Mixer and Amplifier)

REF DESIG	ITEM	PART NO.	MFR
C1301	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1302	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1303	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1304	Capacitor, mica, 130 pf	DM15E131J	Elmenco
C1305	Capacitor, mica, 820 pf	DM15E821J	Elmenco
C1306	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1307	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1308	Capacitor, mica, 270 pf	DM15E271J	Elmenco
C1309	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1310	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1311	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1312	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
CR1301	Diode	1N273	
L1301	Coil	387-1300	Wells Electronics
L1302	Coil	387-1300	Wells Electronics
Q1301	Transistor	2N3904	
Q1302	Transistor	2N3904	
Q1303	Transistor	2N3904	
Q1304	Transistor	2N3904	
R1301	Resistor, composition, 47K ±10%, 1/4 watt		
R1302	Resistor, composition, 10K ±10%, 1/4 watt		
R1303	Resistor, composition, 4.7K ±10%, 1/4 watt		
R1304	Resistor, composition, 1K ±10%, 1/4 watt		
R1305	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1306	Resistor, composition, 47 ohms ±10%, 1/4 watt		
R1307	Resistor, composition, 47K ±10%, 1/4 watt		
R1308	Resistor, composition, 10K ±10%, 1/4 watt		
R1309	Resistor, composition, 330 ohms ±10%, 1/4 watt		
R1310	Resistor, composition, 1K ±10%, 1/4 watt		
R1311	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1312	Resistor, composition, 4.7K ±10%, 1/4 watt		
R1313	Resistor, composition, 100K ±10%, 1/4 watt		
R1314	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1315	Resistor, composition, 100K ±10%, 1/4 watt		
R1316	Resistor, variable, 5K	MTC-1-5K	Mallory
R1317	Resistor, variable, 10K	MTC-1-10K	Mallory

17-1. The mixer and amplifier receives two signals from 100 KHZ selector A1610 and delivers the 400 to 500 KHZ difference signal to phase detector and sweep gate A1614. The assembly also furnishes a sweep gate control voltage.

17-2. A 3 to 4 MHZ and a 2.6 to 3.5 MHZ signal are applied to mixer Q1301 which produces a 400 to 500 KHZ output signal. This signal is applied to the phase detector through amplifier Q1302 and buffer Q1303. The output circuit of the mixer is tuned by coil L1301 and the output circuit of the amplifier is tuned by coil L1302. Potentiometer R1316 provides control of output signal level.

17-3. Detector Q1304 produces a dc output with a level determined by the frequency of the buffer output signal. With a signal within the 400 to 500 KHZ range, amplification is maximum and therefore the output of the detector is maximum. When the signal out of the buffer is outside the 400 to 500 KHZ range, the detector dc output voltage will fall below a predetermined threshold voltage. This threshold voltage is used to prevent false locks on harmonics of the IF signal or harmonics of the LFO frequency.

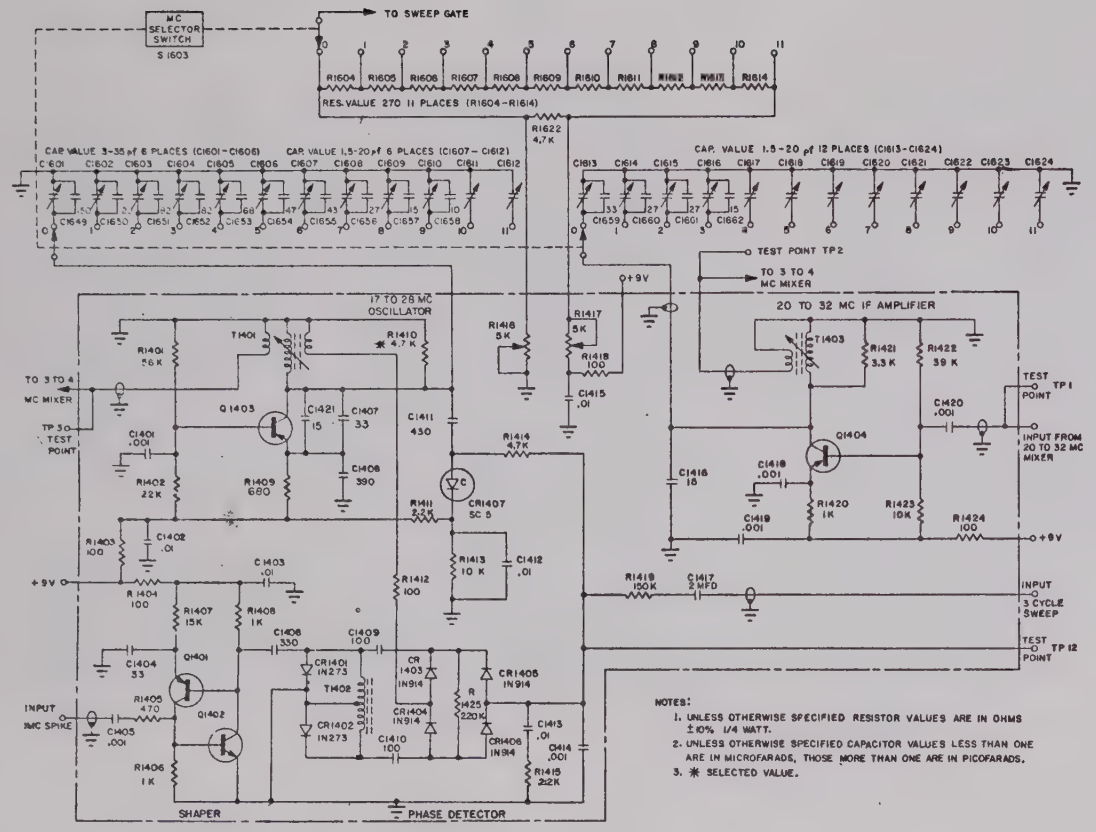


Figure 18-1. Schematic (Megacycle Selector)

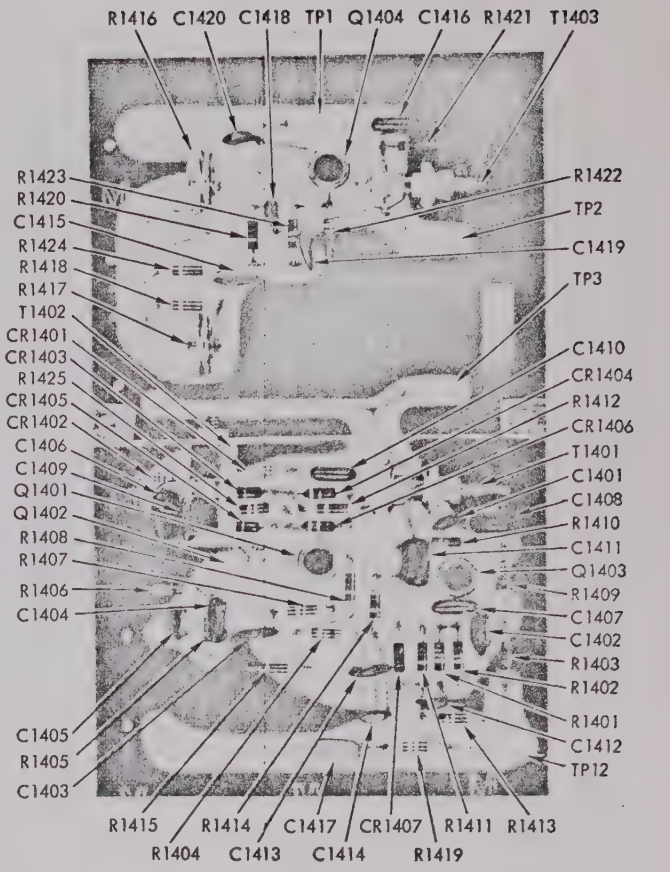


Figure 18-2. Component Location (Megacycle Selector)

REF DESIG	ITEM	PART NO.	MFR
C1401	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1402	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1403	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1404	Capacitor, mica, 33 pf	DM15E330J	Elmenco
C1405	Capacitor, ceramic disc, 0.001 uf	851Z5U102Z	Erie
C1406	Capacitor, mica, 330 pf	DM15E331J	Elmenco
C1407	Capacitor, mica, 33 pf N750	TC1-33	Centralab
C1408	Capacitor, mica, 390 pf	DM15E391J	Elmenco
C1409	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1410	Capacitor, mica, 100 pf	DM15E101J	Elmenco
C1411	Capacitor, mica, 430 pf	DM15E431J	Elmenco
C1412	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1413	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1414	Capacitor, ceramic disc, 0.001 uf	851Z5U102Z	Erie
C1415	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1416	Capacitor, mica, 15 pf	DM15E150J	Elmenco
C1417	Capacitor, electrolytic, 2uf	P65AC10250N	MEC
C1418	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1419	Capacitor, ceramic disc, 0.001 uf	861Z5U103Z	Erie
C1420	Capacitor, ceramic disc, 0.001 uf	861Z5U103Z	Erie
C1421	Capacitor, mica, 15 pf	DM15E150J	Elmenco
CR1401	Diode	1N273	
CR1402	Diode	1N273	
CR1403 thru CR1406	Diode	1N4148	
CR1407	Diode, capacitive element	SC-5	Transitron
Q1401	Transistor	2N3906	
Q1402	Transistor	2N3904	
Q1403	Transistor	2N3906	

REF DESIG	ITEM	PART NO.	MFR
Q1404	Transistor	2N3283	
R1401	Resistor, composition, 56K ±10%, 1/4 watt		
R1402	Resistor, composition, 22K ±10%, 1/4 watt		
R1403	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1404	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1405	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R1406	Resistor, composition, 1K ±10%, 1/4 watt		
R1407	Resistor, composition, 15K ±10%, 1/4 watt		
R1408	Resistor, composition, 1K ±10%, 1/4 watt		
R1409	Resistor, composition, 680 ohms ±10%, 1/4 watt		
*R1410	Resistor, composition, 4.7K ±10%, 1/4 watt *selected value		
R1411	Resistor, composition, 2.2K ±10%, 1/4 watt		
R1412	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1413	Resistor, composition, 10K ±10%, 1/4 watt		
R1414	Resistor, composition, 4.7 ±10%, 1/4 watt		
R1415	Resistor, composition, 2.2K ±10%, 1/4 watt		
R1416	Resistor, variable, 5K	MTC-1-5K	Mallory
R1417	Resistor, variable, 5K	MTC-1-5K	Mallory
R1418	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1419	Resistor, composition, 150K ±10%, 1/4 watt		
R1420	Resistor, composition, 1K ±10%, 1/4 watt		
R1421	Resistor, composition, 3.3K ±10%, 1/4 watt		
R1422	Resistor, composition, 39K ±10%, 1/4 watt		
R1423	Resistor, composition, 10K ±10%, 1/4 watt		
R1424	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1425	Resistor, composition, 220K ±10%, 1/4 watt		
T1401	Transformer	EP71	Singer
T1402	Transformer	LR-28	Singer
T1403	Transformer	EP73	Singer
TP1 thru TP3 & TP12	Test Point	119437-11	Ucinite

18-1. The megacycle selector receives a 20 to 32 MHZ signal from mixer Q1003 and a 1 MHZ spike from the spike generator. The selector delivers two signals with a difference frequency between 3 and 4 MHZ, to mixer Q1501 of 100 KHZ selector A1610.

18-2. The 20 to 32 MHZ signal from mixer Q1003 is amplified by IF amplifier Q1404. The output circuit is tuned by transformer T1403 and by selection of capacitors. MHZ selector switch S1603 selects a trimming capacitor tuned for maximum response within a one megacycle range.

18-3. Oscillator Q1403 is tuned to approximate frequency by selection of capacitors (C1613 through C1624) and to an exact multiple of 1 megacycle by the phase detector. The oscillator supplies a 17 to 28 MHZ signal to the 3 to 4 megacycle mixer and to the diode bridge of the phase detector.

18-4. The shaper Q1401 and Q1402 receives a 1 MHZ spike from the spike generator and supplies a gate pulse with a very narrow pulse width to the diode bridge. As in the shaper of the spike generator (see Section 10), the back-to-back transistors provide positive feedback and therefore sharp rise and fall characteristics. The pulse is applied to the diode bridge through transformer T1402.

18-5. When the gate pulse is applied to the bridge, the four diodes conduct and apply a portion of the oscillator signal to reactance diode CR1407. This portion is filtered by capacitors C1413 and C1414 and is a dc voltage. As shown in figure 18-3, the dc output level is determined by the phase relations between the gate pulse and the oscillator signal. If the local oscillator drifts, the phase relations change and produce a change in dc output. The change in dc output changes the effective capacitance of the reactance diode and automatically corrects the frequency drift.

18-6. This type of bridge has a very narrow lock range. To assist the circuit in locating a lock voltage, a three cycle sweep voltage from sweep generator Q301 and Q302 is applied to diode CR1407. Before lock is achieved, this three cycle signal is effectively a dc sweep voltage which sweeps the oscillator over a broad frequency range. Once lock is achieved, the circuit compensates for the dc change and effectively cancels the sweep action.

18-7. Resistors R1416, R1417, and R1418 are part of the voltage divider network for the final phase detector. The network supplies a dc reference voltage to the detector.

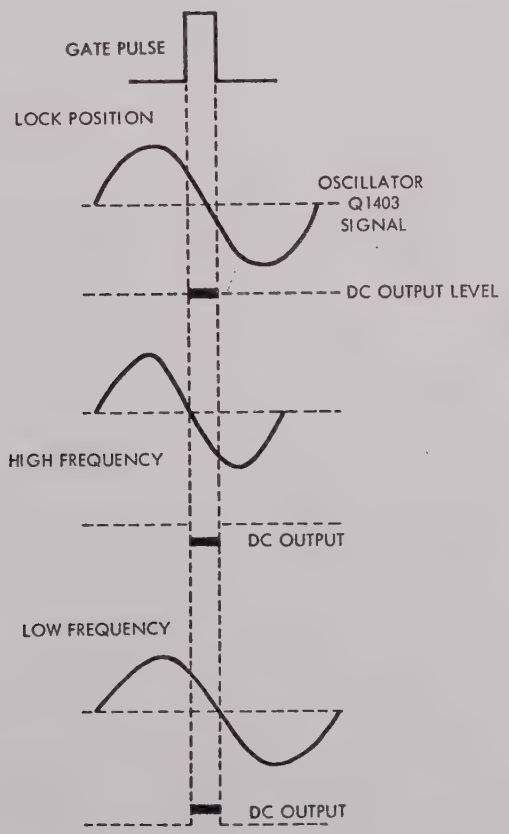


Figure 18-3. Phase Lock Bridge Waveforms

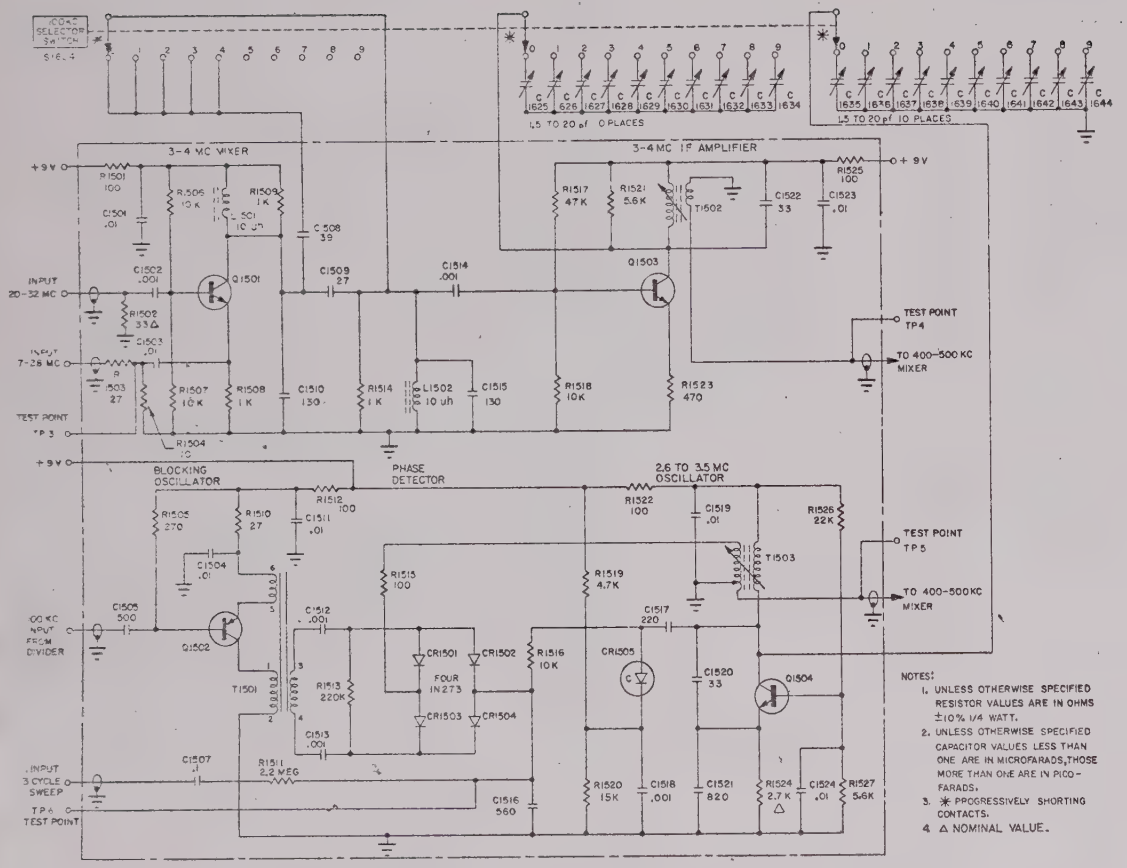


Figure 19-1. Schematic (100 KHZ Selector)

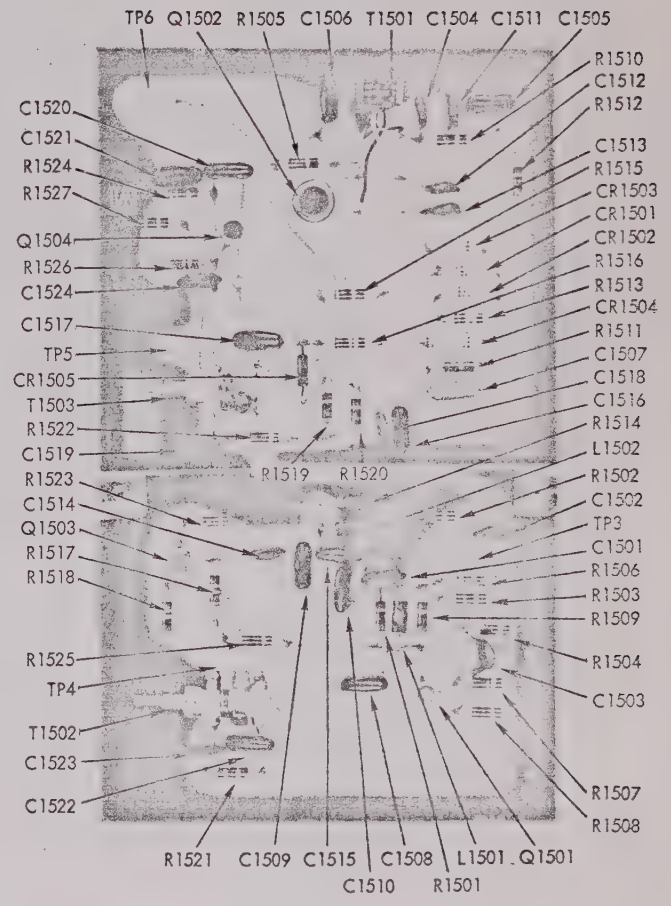


Figure 19-2. Component Location (100KC Selector)

REF DESIG	ITEM	PART NO.	MFR
C1501	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1502	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1503	Capacitor, ceramic disc, 0.01 uf	861Z5U103Z	Erie
C1504	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1505	Capacitor, mica, 500 pf	DM15E501J	Elmenco
C1507	Capacitor, mylar, 0.1 uf	C280AA/P100K	Amperex
C1508	Capacitor, mica, 39 pf	DM15E390J	Elmenco
C1509	Capacitor, mica, 27 pf	DM15E270J	Elmenco
C1510	Capacitor, mica, 130 pf	DM15E131J	Elmenco
C1511	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1512 thru C1514	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1515	Capacitor, mica, 130 pf	DM15E131J	Elmenco
C1516	Capacitor, mica, 560 pf	DM15E561J	Elmenco
C1517	Capacitor, mica, 220 pf	DM15E221J	Elmenco
C1518	Capacitor, ceramic disc, 0.001 uf	861Z5U102Z	Erie
C1519	Capacitor, ceramic disc, 0.01 uf	MR330-.01	Paktron
C1520	Capacitor, mica, 33 pf, N750	TCN-33	Centralab
C1521	Capacitor, mica, 820 pf	DM15E821J	Elmenco
C1522	Capacitor, mica, 33 pf	DM15E330J	Elmenco
C1523	Capacitor, ceramic disc, 0.01 uf	851Z5U103Z	Erie
C1524	Capacitor, ceramic disc, 0.01 uf	861Z5U103Z	Erie
CR1501 thru CR1504	Diode	1N273	
CR1505	Diode, voltage sensitive	SC2	Transitron
Q1501	Transistor,	2N3904	
Q1502	Transistor	2N1742	
Q1503	Transistor	2N3904	
Q1504	Transistor	2N3904	
L1501	Coil, 10 uh	70F105A1	Miller
L1502	Coil, 10 uh	70F105A1	Miller

REF DESIG	ITEM	PART NO.	MFR
R1501	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1502	Resistor, composition, 33 ohms ±10%, 1/4 watt		
R1503	Resistor, composition, 27 ohms ±10%, 1/4 watt		
R1504	Resistor, composition, 10 ohms ±10%, 1/4 watt		
R1505	Resistor, composition, 270 ohms ±10%, 1/4 watt		
R1506	Resistor, composition, 10K ±10%, 1/4 watt		
R1507	Resistor, composition, 10K ±10%, 1/4 watt		
R1508	Resistor, composition, 1K ±10%, 1/4 watt		
R1509	Resistor, composition, 1K ±10%, 1/4 watt		
R1510	Resistor, composition, 27 ohms ±10%, 1/4 watt		
R1511	Resistor, composition, 2.2 meg ±10%, 1/4 watt		
R1512	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1513	Resistor, composition, 220K ±10%, 1/4 watt		
R1514	Resistor, composition, 1K ±10%, 1/4 watt		
R1515	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1516	Resistor, composition, 10K ±10%, 1/4 watt		
R1517	Resistor, composition, 47K ±10%, 1/4 watt		
R1518	Resistor, composition, 10K ±10%, 1/4 watt		
R1519	Resistor, composition, 4.7K ±10%, 1/4 watt		
R1520	Resistor, composition, 15K ±10%, 1/4 watt		
R1521	Resistor, composition, 5.6K ±10%, 1/4 watt		
R1522	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1523	Resistor, composition, 470 ohms ±10%, 1/4 watt		
R1524	Resistor, composition, 2.7K ±10%, 1/4 watt		
R1525	Resistor, composition, 100 ohms ±10%, 1/4 watt		
R1526	Resistor, composition, 22K ±10%, 1/4 watt		
R1527	Resistor, composition, 5.6K ±10%, 1/4 watt		
T1501	Transformer	PIP-2	UTC
T1502	Transformer	EP74	Singer
T1503	Transformer	EP75	Singer
TP3 thru TP6	Jack	119437-11	Amperex

19-1. The 100 KHZ selector receives two signals from megacycle selector A1607 and a 100 KHZ signal from frequency divider A1612. The selector delivers two signals with a difference frequency between 400 and 500 KHZ to mixer Q1301 of 400 to 500 KHZ mixer and amplifier A1613.

19-2. A 20 to 32 MHZ and 17 to 28 MHZ signal are applied to mixer Q1501 which produces a 3 to 4 MHZ output signal. The output circuit of the mixer is tuned to provide a 1 megacycle band pass. The 3 to 4 MHZ signal is amplified by amplifier Q1503 and delivered to the 400 to 500 KHZ mixer. 100 KHZ selector switch S1604 selects a trimming capacitor tuned for maximum response within a 100 KHZ range.

19-3. Oscillator Q1504 is tuned to approximate frequency by selection of capacitors (C1635 through C1644) and to an exact multiple of 100 KHZ by the phase detector. The oscillator supplies a 2.6 to 3.5 MHZ signal to the 400 to 500 KHZ mixer.

19-4. The phase detector operates in the same manner as the phase detector in the megacycle selector (see Section 18). The detector receives a 100 KHZ gate pulse from frequency divider A1612. The 100 KHZ pulse is shaped by blocking oscillator Q1502.

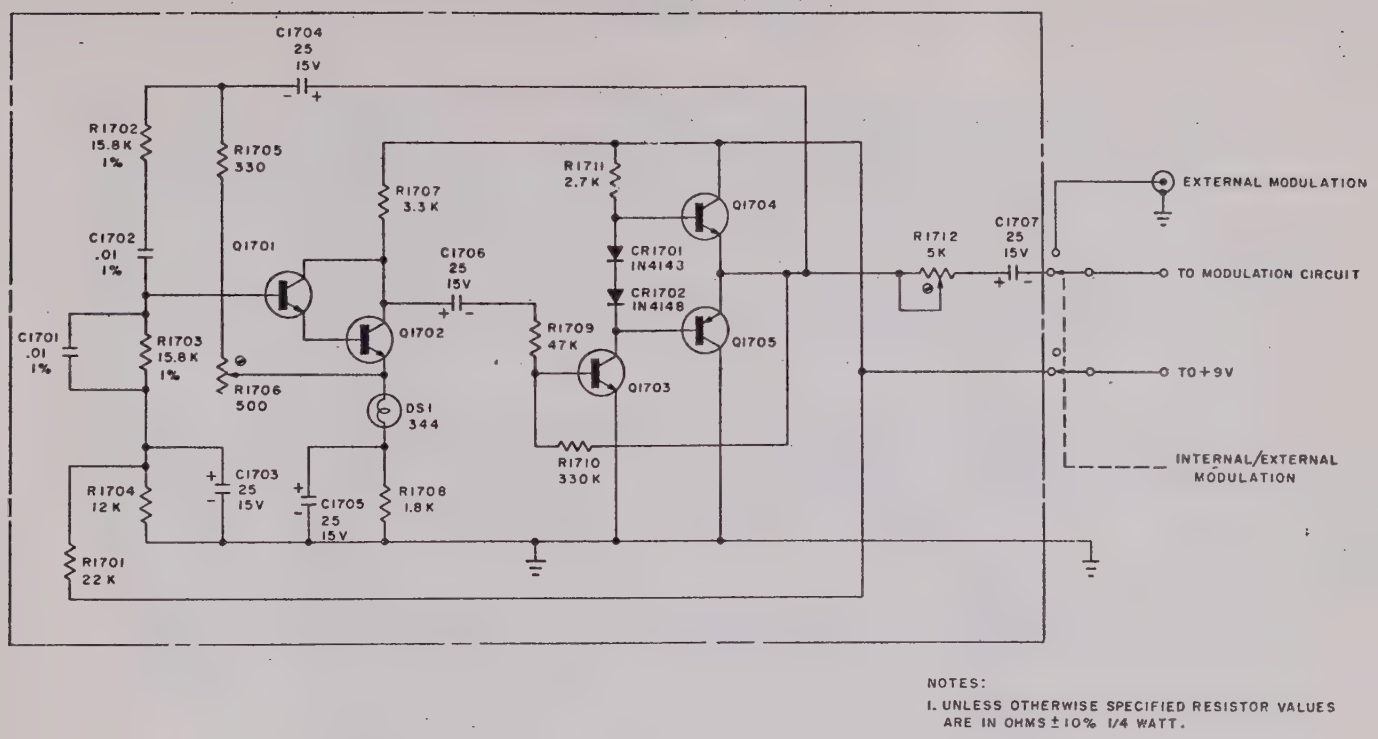


Figure 20-1. Schematic (1KHZ Oscillator)

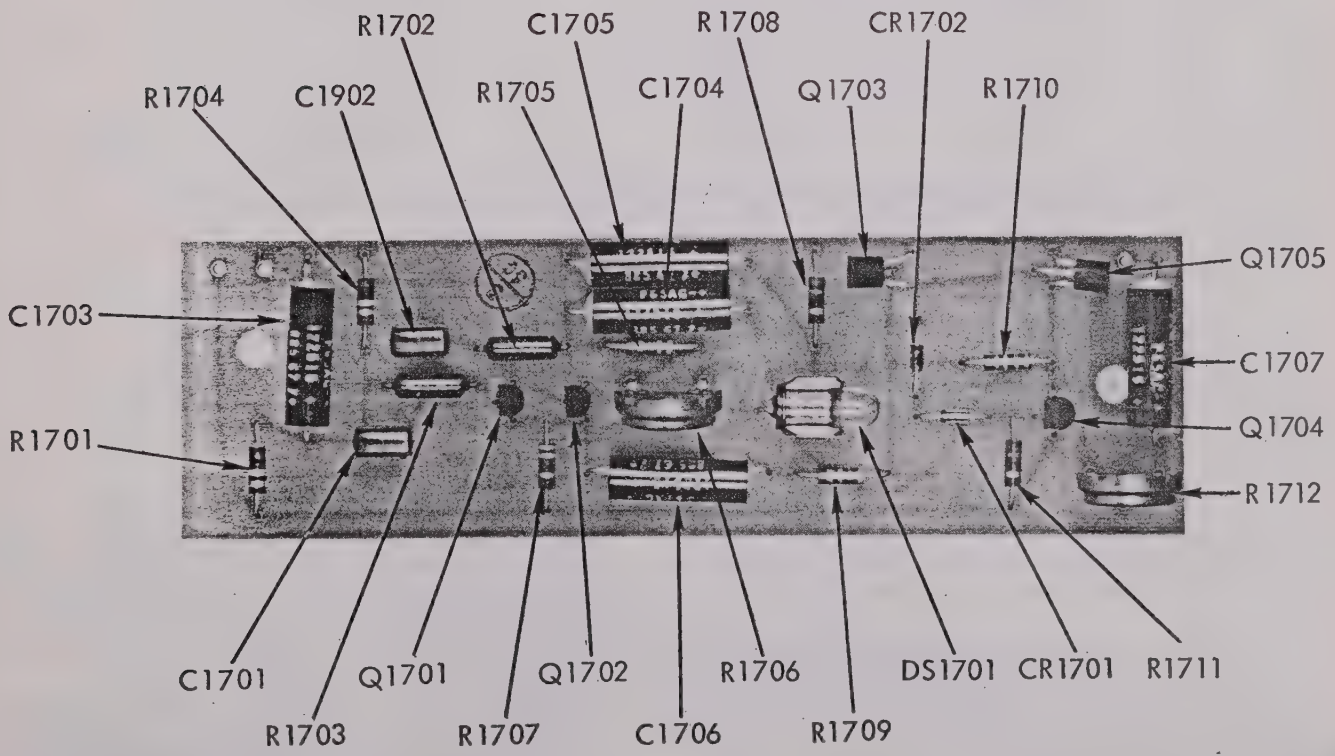


Figure 20-2. Component Location (1 KHZ Oscillator)

REF DESIG	ITEM	PART NO.	MFR
C1701	Capacitor, plastic, .01 uf ± 1%, 50 v	MR330-.01	Paktron
C1702	Capacitor, plastic, .01 uf ± 1%, 50 v	MR330-.01	Paktron
C1703	Capacitor, electrolytic, 25 uf, 15 v	P65AG122515	MEC
C1704	Capacitor, electrolytic, 25 uf, 15 v	P65AG122515	MEC
C1705	Capacitor, electrolytic, 25 uf, 15 v	P65AG122515	MEC
C1706	Capacitor, electrolytic, 25 uf, 15 v	P65AG122515	MEC
C1707	Capacitor, electrolytic, 25 uf, 15 v	P65AG122515	MEC
CR1701	Diode	1N4148	GE
CR1702	Diode	1N4148	GE
DS1701	Lamp, incandescent	344	GE
Q1701	Transistor	2N3904	
Q1702	Transistor	2N3904	
Q1703	Transistor	2N3904	
Q1704	Transistor	2N3904	
Q1705	Transistor	2N3906	
R1701	Resistor, composition, 22K ±10%, 1/4 watt		
R1702	Resistor, film, 15.8K ±1%, 1/8 watt	RN60D1582F	
R1703	Resistor, film, 15.8K ±1%, 1/8 watt	RN60D1582F	
R1704	Resistor, composition, 12K ±10%, 1/4 watt		
R1705	Resistor, composition, 330 ohms ±10%, 1/4 watt		
R1706	Resistor, variable, 500 ohms	MTC-1500	Mallory
R1707	Resistor, composition, 3.3K ±10%, 1/4 watt		
R1708	Resistor, composition, 1.8K ±10%, 1/4 watt		
R1709	Resistor, composition, 47K ±10%, 1/4 watt		
R1710	Resistor, composition, 330K ±10%, 1/4 watt		
R1711	Resistor, composition, 2.7K ±10%, 1/4 watt		
R1712	Resistor, variable, 5K	MTC-1-5K	Mallory

20-1. The circuit forms an RC type of oscillator (negative resistance) with both positive and negative feedback. The oscillator delivers a 1 KHZ signal with an amplitude of approximately 6 v peak-to-peak.

20-2. The positive feedback is applied through the RC network consisting of capacitors C1701 and C1702 and of resistors R1702 and R1703. At 1 KHZ, the feedback through this circuit is maximum (since the phase shift through the series and parallel networks are approximately equal and of opposite sign).

20-3. The negative feedback is applied through variable resistor R1706 and minimizes distortion. Lamp DS1701 is used as a variable resistive element. When gain through the oscillator is low, current through the light is low and thus the emitter resistance is low. As gain increases, resistance increases and effectively increases the amount of negative feedback.

20-4. The output waveform at C1707 should be a reasonable pure sine wave, 1000 HZ, with an amplitude of approximately 6 v peak-to-peak. Adjust R1706 as required to minimize distortion.

MODEL RFA-40

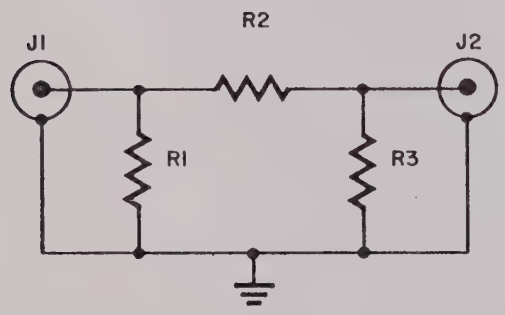
RF ATTENUATOR

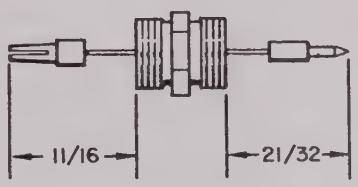
The Model RFA-40 is a 40db attenuator, designed for use with the Gertsch FM-9E Frequency meter and must be used with the FM-9E to provide accurate output levels in the .05 to 5uv range.

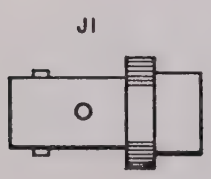
In addition to providing a 20 to 1 voltage reduction of the FM-9 output, the RFA-40 protects the frequency meter from damage due to accidental keying of transceivers.

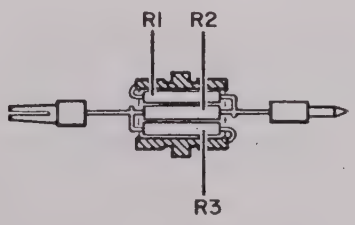
Accidental keying of the transmitter, when directly connected to the FM-9 through the RFA-40, may result in a significant change in the impedance or attenuation of the RFA-40. A set of spare resistors is provided with the unit, should this occur.

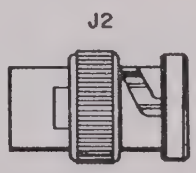
The replacement resistors are mounted as shown in the exploded view below. Particular attention must be given to the dimensions shown.











Parts List

J1	Connector, UG-89 C/U
J2	Connector, UG-88 C/U
R1	Resistor, film, 51 ohms ± 1%, 1/8 w
R2	Resistor, film, 2.49K±1%, 1/8 w
R3	Resistor, film, 51 ohms ± 1%, 1/8 w

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Model RFA-60 RF Attenuator

The Model RFA-60 is a 60 db attenuator which allows keying of a transmitter when directly coupled to the Model FM-9 Frequency Meter.

Connect the attenuator into the test circuit as follows:

1. Connect the cable end (BNC connector) of the attenuator directly to the INPUT/OUTPUT connector of the Model FM-9.
2. Connect the transmitter/receiver to one of the UHF connectors of the tee.
3. The remaining UHF connector of the tee is for connection of a dummy load or an antenna.

The 60 db (1000:1 voltage) attenuation applies in the fundamental 150 to 162 MC range only.

Receiver sensitivity checks may be made with the above test circuit, however, allowance must be made for the 1000:1 attenuation. Use the 5mv scale of the Model FM-9 to obtain a .5uv output.

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